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COMMODORE JNO. H. RUSSELL, U. S. N., in the Chair.

SOME SUGGESTIONS FOR MANNING OUR FUTURE NAVAL VESSELS.

BY COMMANDER HENRY GLASS, U. S. N.

With the introduction into our Navy, in the near future, of modern steel vessels of the highest attainable speed, with reduced top hamper and small spread of canvas, armed with high-power breech-loading rifled guns and rapid-firing machine guns of the most approved patterns, and fitted with complicated torpedo apparatus, it is obvious that a radical change must soon be made in the character of the *personnel* of our vessels of war, and in the methods of instruction and drill adopted, if we are to secure the objects for which are incurred the large expenditures necessary to create and maintain a modern naval force; that is, ships ready under all circumstances for any service required on the ocean in defence of the national interests.

It may safely be assumed that the Naval Academy at Annapolis, as now organized and equipped for the instruction and primary training of the future officers of the naval service, will keep pace with all modern improvements in naval architecture and ordnance, including in the latter branch the fabrication and management of torpedoes for

defensive as well as offensive purposes, and that it will continue in the future, as in the past, to send into the service young officers fully competent, with the experience gained in a few years afloat, to instruct and control the men placed under their command, and to handle to the best advantage the ships and guns provided by the Government. I propose, then, to offer for diccussion on this occasion some suggestions of what I consider necessary to give the highest efficiency to the enlisted men of the Navy, as being a subject of the most vital importance just now to the service.

In my opinion, certain important changes are required in the methods of enlistment and rating and pay of the men who are to serve in our vessels of war now nearing completion, or soon to be in course of construction, in order to secure a more efficient class of men than seems possible under the present system of enlistments for general service, or entry into the service through the apprentice-training ships, however admirable the latter means of recruiting for the Navy may have been under former conditions.

The complement of men assigned to our vessels of war has always depended primarily on the number of guns carried, with an additional force, in later times, to manage the engines and their dependencies in steamers. The class of guns, now become obsolete, that formerly composed the batteries of our ships required in action a number of men always in excess of the number needed to handle a vessel not in action, even in the days when sails were the only motive power at sea. If, then, as seems to be demonstrated in practice, the heavy guns at present used at sea can be handled with fewer men than formerly, there need be no hesitation in decreasing the complements of our vessels, provided we can secure greater efficiency among the men. Steamers of all classes will have even less sail power in future than is now considered necessary in our service, and the Admiral of the Navy, long an advocate of full sail power for vessels of war, has lately proposed building as a type-vessel an armed cruiser with absolutely no sail power. This is an extreme view not likely to be adopted; for, while ships cruise at sea, they will always have sufficient sail power to at least be kept under control in case of accident to the machinery or while lying to in a gale of wind. With the introduction of the modern guns, served, trained, and fired by mechanical appliances, the number of men required on board ships hereafter will certainly be largely decreased, but a much higher class of men will be found necessary to care for, handle, and, in case of

need, repair the complicated mechanism of the battery, than are now enlisted in the service.

At the same time that we shall, with smaller crews, avoid the overcrowding of men on the berth-deck, seen on so many of our vessels of to-day, there will be secured greater comfort for the men, better attention to hygienic conditions, and consequent increased efficiency of the crew of a ship as a whole. A better distribution of the berthing space can be secured, with increased stowage capacity for ordnance stores, coal and provisions, thus enabling our ships to keep the sea for longer periods cruising or on blockading duty, as the case may be. With the smaller number of men on board will be found also a decreased list of casualties in action.

But while, as said before, the modern guns will require fewer men to handle them, those men must be of highly trained mechanical ability, and to secure them for the service, higher rates of pay must be provided, with other advantages not now enjoyed by the enlisted man. The seaman of the future ships must be more than a smart topman: he must also be an artilleryman and a mechanic. It is not intended by this to assert that the highest type of seamanship is not an absolute necessity in the Navy. That will always be of the first importance, and the ship with the quickest, readiest men will, other things being equal, be found the most efficient vessel of war; but it is contended that men of the intelligence and skill required to work the modern gun, with all its complicated machinery, can easily acquire, and in a short time, all the essential knowledge of gear and sails required to perform the ordinary duties of a seaman on deck, or even aloft, in a gale of wind or while the ship is temporarily under canvas alone.

The seamanship of the future will in some respects differ as greatly from that of the past as do the vessels themselves from the old sailing ships. Sending up and down topgallant and royal yards, reefing topsails for exercise, and evolutions of a kindred nature, will no longer be practised, as they will no longer furnish the test of the readiness and efficiency of a ship's company; but handling the ships themselves under varying conditions of speed and weather, and performing the tactical movements of a squadron, will serve as a standard of comparison for ships and crews; and all this will require a sound judgment of the capacity of vessels of different types and a quickness to perceive and use accidental advantages that the present training of the service does not give.

Officers and men alike must learn, however reluctantly in some cases, that the naval service of the future will have little of romance, but that it will be a cool, ready, business-like application of the means furnished by modern science and research to the destruction of an enemy's vessels of war at the least possible cost to the country, with few, if any, opportunities for the display of personal prowess in boarding parties or cutting-out expeditions. The future policy of our Government undoubtedly will be to maintain a well-organized nucleus of a naval force of the highest character, rather than to keep afloat at all times an expensive establishment such as those possessed by some European powers; the ships of different types, to meet the varying conditions of service, especially in our own waters, all of the highest attainable efficiency, with highly trained officers, and the fewest number of men to each ship that may be found necessary in ordinary cruising. Every ship in commission will become to a great degree a training school from which can be drafted as needed a few men to fill essential positions among the crews of additional vessels put in commission in case of threatened hostilities.

It may be objected that the reduction in the crews of our ships suggested will render impossible hereafter landing parties to be employed in shore operations. To this the answer, in my opinion, should be that the men and officers of a vessel of war should never be sent on any service beyond the reach of her broadside guns; that the highest state of efficiency of which a man-of-war is capable, and the one in which she best fulfills the object of her existence, is when her guns are ready for action at any moment, manned by their proper crews; and, lastly, that the men who are to handle our guns in future will be too valuable material to be lightly risked to accomplish the small results that have usually followed sending parties of seamen away from their ships. That part of hostile operations had much better be left to land forces, to be taken rapidly from point to point as necessary by a well-organized transport service, for which the Navy could be called upon to furnish the few sea officers needed in time of actual war.

To obtain the class of men required in the service, rates of pay must be established such as skilled mechanics can command on shore, with the additional advantages of continuous pay while not on duty afloat, and reasonable retiring pensions for age or disability incurred in the line of duty, as compensations for the hardships and exposure of a life at sea always to be reckoned upon under the most favorable

conditions. Instead of asking Congress to increase the number of men now allowed in the Navy, with consequent larger appropriations for their pay, which is certainly most inadvisable until we have a much larger number of vessels in commission than at present, I would reduce the number of men in the service to its actual needs, keeping a proper reserve for ships fitting out, and apply the amount of money thus saved to increasing the pay of every rated man retained in the service. In this way, without additional cost to the country, can be obtained the object proposed, and a class of men secured and retained in the Navy in every way competent to perform all the duties to be required of them in the future. The enlisted men will be found more trustworthy in all respects, and they will possess an *esprit de corps* not possible under the present system.

While I hold that the training ships now in commission are not meeting the requirements of the future, and that from the nature of things they cannot do so, I am far from advocating an abandonment of the system. But I would urge that essential modifications be made in the course of instruction and drills pursued that are not possible while the old sailing sloops of war, with their antiquated armaments, are retained as school ships for the Navy. The boys and young men enlisted for future service in the Navy, at considerable expense to the Government, should be instructed, from the very beginning of their service, in handling the guns and appliances that they may at any time be called upon to use in battle. I would at once substitute for the sailing sloops now composing the training squadron, modern steamers lightly rigged, armed with the modern guns of the service, and fitted with torpedo apparatus and all the appliances of a cruiser of the present day, such as machine guns, search lights, and electric firing apparatus for the battery.*

These vessels should be kept cruising on our own coast, and a portion of every year of instruction should be spent at the steel works and foundries where the guns for the Navy are being constructed, in order that all the details of the guns and their carriages should be thoroughly understood. A number of those trained for future service should every year be taken into the shops and be required to perform

*Since the above was written (Nov. 16), the reports of the Bureau Officers of the Navy Department have been given to the press, and the same suggestions practically are found in the reports of the Chiefs of the Bureaux of Equipment and Recruiting and Construction, and appropriations are asked for to carry them into effect.

a portion of the mechanical work, to familiarize them with the use of tools, and to fit them to care for the guns when in actual service, and to make slight repairs that may become necessary on board ship.

To sum up, then, the following propositions are submitted:

Reduce the number of men in the service to its actual needs when the new ships are in commission, retaining only those of the highest intelligence and skill.

Increase the pay and allowances of the number retained to such a scale as will secure for the service skilled mechanics who are also seamen.

Change the whole course of drills and instruction in the training ships, to bring the apprentice system into accord with the new condition of affairs in the Navy.

It is, I believe, beyond question that the present force of enlisted men in the Navy cannot be trusted to perform the duties specified as being required in the future, and should we be forced, from want of the proper class of men, to rely upon the *personnel* we now have for the safety of our future ships, and to maintain the honor of the flag in action against a thoroughly equipped, alert enemy, all thoughtful persons will look with grave apprehensions to the result of such a policy. It is only by the skill of the officers of the Navy, aided by a mere handful of the men we have, and possibly by fortunate chances, that disaster and disgrace would be averted.

The question of keeping faith with the large number of continuous-service men and apprentices we now have in the Navy may be raised; but an easy solution would be found in subjecting every man to a rigid examination as to his present fitness for duty under the new conditions of modern warfare, retaining under their certificates, with increased pay, those who pass successfully and discharging all others with reasonable retiring pensions. Granting that this would entail some temporary expense, an action lost through retaining inefficient men in the service would inflict far greater loss on the country than to pay service pensions for the next fifty years to every man so discharged.

It may seem premature to attempt now to decide upon the qualifications of the men who are to serve in ships yet unbuilt, and for which appropriations have not yet been made; but it must be clearly understood that the present ships and guns of our navy are obsolete, and if we are to have a naval force at all commensurate with the interests to be protected—and no one who has studied the

course of public opinion will question this—new ships must be at once commenced and rapidly pushed to completion.

In addition to the sums already appropriated for rebuilding the Navy, the Navy Department is now asking for a much larger amount, to commence building the new ships that will be needed within a very few years to replace all those now in commission, if the flag is to be carried at sea by an American vessel of war. The ships now in commission have nearly all been kept afloat simply by a system of temporary repairs that, from the very nature of things, will soon become impossible. Enough is known to-day of the future of naval construction in certain lines, as shown by foreign precedent and the conclusions of the Board lately organized, to decide upon the character of our new vessels, and of the class of guns that will be carried, as indicated in the plans of our Ordnance Bureau, to decide approximately upon the character and necessary strength of the crews that must be provided.

Under the most favorable conditions, years are occupied in building and arming a modern vessel of war; but how much longer time will be required to train the brain, the eye, and the hand of the man who is to manage the complicated machinery with which modern invention has replaced the armaments of a quarter of a century ago! No time, then, should be lost by the officers of the service in deciding upon what is necessary, and in formulating plans that will meet the needs of the present and the future. We must all soon be prepared to assume the responsibilities of a new condition of affairs in the naval service, and must expect to be held to a strict accountability by the country for the use we make of the means provided by the Government for carrying on the operations of the national defence at sea.

DISCUSSION.

Lieutenant DANIEL DELEHANTY.—*Mr. Chairman and Gentlemen:*—With regard to the problem of selecting and training the best material for the continuous-service men of the future, I think they should all be given the same facilities for obtaining the knowledge required for the new conditions in the Navy, and to this end I would like to see each ship we now have in commission supplied with at least one of the modern high-power guns, and have every man that is likely to be retained permanently in the service thoroughly instructed in

all the details of duty connected with them. Every ship in commission should be, as soon as possible, fitted with all the modern appliances for naval warfare, so that not only the men, but the officers as well, might become thoroughly familiar with them, and then their transfer from one of our obsolete hulks to a modern man-of-war would not be the bewildering change it is sure to prove under existing circumstances.

I cannot agree with the idea advanced that the seaman of the future must be a mechanic. Both seamen and mechanics will be necessary in their proper places, and the number of seamen might be decreased and the number of mechanics among the crew fixed at the number found necessary in actual service.

I fail also to see how the seamanship of the future will differ from the past except in range of duties. Spar drills will become obsolete, and reefing and furling less frequent, but for marline-spike seamanship, manning and handling boats, steering, etc., the handy seaman will always be required on board our ships. No matter how much the form of the ships may change, the qualities that make up what we term seamanship will always be necessary. Admitting all that can be urged as to the great importance of the duties of the guns' crews in action, it must be remembered that a ship is the means of carrying guns into action, and that this service will, as much as ever, require skillful seamanship. I doubt if the writer would be willing to command a vessel cruising at sea with a complement of men made up simply of mechanics, however skilled they might be in handling and repairing gun machinery.

On the score of economy, as well as availability, I consider the sailing ships we still have in the Navy the most suitable for training purposes, as it is only under canvas, and by taking the weather as it comes at sea, that the qualities of the seaman will be developed; but those vessels should be supplied with modern ordnance and all the appliances of a modern man-of-war, as is suggested for the proposed light-rigged steamers. Instead of spending a portion of every year at the steel works and gun foundries, to give all the men a knowledge of the mechanical work of guns and carriages, the necessary number of men, with adequate rates of pay, might be drawn annually from those establishments for duty on board ship. The pay and the responsible positions they would hold would be, I think, sufficient inducements to attract and retain in the service reliable and skilled mechanics.

Commander FREDERICK RODGERS.—*Mr. Chairman and Gentlemen:*—In my opinion, the necessity for a number of trained seamen on board a vessel of war, in fact, a number sufficient to form the bulk of the crew, will never be overcome. While the mechanical appliances are greatly increased, and consequently the number of mechanics, the same necessities for seamen remain, even for a ship without sails. We must have our expert leadsmen, helmsmen, and lookouts—the boats must be manned—and particularly on picket duty will seamen be required. In cases of sudden emergencies the same necessities present themselves, and, as a rule, I presume it will be found in the future, as heretofore, that the most active, intelligent seamen will be the best men at the guns. If it is

practicable to carry out a course of instruction that will introduce mechanics who are also sailors, so much the better.

There certainly can be no question in the mind of any officer who has given attention to the subject under discussion, that the principle upon which the paper read by Commander Glass is founded is sound; that is, that the education or instruction of the *personnel*, the men as well as the officers, must necessarily, in order that they shall be efficient, keep pace with the advance in the improvements of all the mechanical appliances for war. That we have made practically no advance in the latter for many years, may account for the fact that there has been scarcely any change made in the system of employing and instructing men in the Navy. As is suggested in the paper just read, much will be gained by anticipating the radical change now promised, and thus prepare the men, so far as is practicable, for the handling of the most modern implements of war. It is only in the matter of detail, or as to how this can be best effected, that there can be a difference of opinion. It seems to me, if the Navy is to be brought up to a proper standard, even with a reduction of the complements of vessels, that the present number of men allowed to the Navy will be small. Ten thousand men, not including apprentices, would be a small number, were the Navy increased to anything like a force adequate to our wants. No one will deny that the proper place to begin a radical change in the system of instruction is at the root of it; and in this case, of course, that should be with the apprentices. It is well known that in this country, where opportunities in civil life offer so many inducements to leave the service when still young, that, in order to retain a desirable number of men with military training, it is necessary to begin with a large number of novitiates. Look, for instance, at the small percentage of officers found in the service at the end of ten years from entering a class at West Point or Annapolis. The percentage of men remaining in the service who are derived from the apprentice system is still smaller—perhaps not ten per cent.—after supplying the proper means to train apprentices with modern appliances. The number of apprentices in training should be increased to at least twelve or fifteen hundred. The term of enlistment for general service, I think, perhaps should be five years instead of three.

In reference to the pay of men, I am not sure that it would be necessary to increase it materially. The pay of the men in our service seems to be sufficiently greater than that in other services. The pay, however, should unquestionably be equalized, and that of seamen gunners—which it seems to me would be the proper title—raised to agree more nearly with that of machinists, boilermakers and other mechanics. In the instruction of the *personnel*, classes of men rated respectively seamen gunners and armorers would seem to be the most important. At the present time an armorer gets $45.00 per month, and a machinist $70.00; the former, from the nature of things, should be worth as much as the latter. A second-class fireman receives at present six dollars more a month than a seaman, and we know how much more a man has to learn in order to become a seaman. The pay ought certainly at least to be equal. A first-class fireman gets one dollar more a month than a seaman gunner. In order properly to proportion them, if a seaman gunner is what he is intended

to be, he should at least have $40.00 or $45.00 a month. There are many good men now in the service with a C. S. C. who are capable of instruction; from my experience, the greater part of this class who are not too old might be retained. There is a large number of men advanced in years who will in any event soon pass out. With the present requirements of grading men for C. S. C., none but desirable men would remain, if the requirements were exacted.

Lieutenant-Commander R. M. CUTTS.—*Mr. Chairman and Gentlemen:*—I agree with Commander Glass in many of his points, but have a few suggestions to make. I do not believe that we shall, for many years, be able to class closely our new ships; therefore, rules for allowances for crews cannot be made generally, but a special one for each vessel will be necessary.

The men composing such a crew should be divided into two classes: skilled, such as gunners, torpedo men, and electricians, or perhaps call them by some other name; the other class to be composed of men of about the same type as the best of our present force.

On each vessel there should be enough of the first class to fully man the modern guns, take care of the torpedoes, and manage the electric lights and wires. These men should be selected from graduating apprentices sent first to the Ordnance Proving Ground at Annapolis, and then to the Torpedo School, or *vice versa*. The pay of these skilled men should be gradually raised as they progress in information, and after graduation they should be held subject to draft. Some of these men, of course, would develop special leanings towards the different subjects in which they are instructed, which would indicate the rates to which they should be appointed. I think this would form a permanent force capable of performing all the duties connected with the care and use of all the apparatus soon to be used on all men-of-war.

The second class should be, as I said before, of the type of our present force—the best type, of course.

I do not believe in landing parties, for, with the modern type of men-of-war, having so few guns and so few men to each gun, it would not be right to deplete the ship's company to the extent that would make the landing a success.

I think that the plan of putting enlisted men at work in steel manufacturing shops and others would not prove a success. I have seen it tried at the Washington Navy Yard with the seamen gunners, but they took so little interest that, in my opinion, the plan was a failure.

I also think that seamanship will not play a prominent part in the modern cruiser. Of course, the second class must be sea-going men, and, if possible, from the Training Squadron; but I think it is not necessary to have that high grade of seamanship-knowledge that was a necessity in former years.

Commander GLASS.—*Mr. Chairman and Gentlemen:*—I think there is some misapprehension of my position as to the need of seamanship in the future, or rather, the manner in which I would define seamanship. Seamanship is, I take it, intelligence and skill applied to the performance of duties on board a ship. Now, modern vessels of war are so different in general arrangement, rig, speed,

and armament, that the duty to be performed by the men of the crew will offer few points of comparison with that required on board the old sailing ships, whose rig, at least, we have perpetuated in the vessels we now have in commission, with the single exception of the Dolphin.

The old-time seaman, or quartermaster, who could keep a ship "full and by" to perfection, and make every possible inch to windward, would be quite lost if placed at the wheel of a steamer making, say, sixteen or eighteen knots, and changing course possibly every few moments. The same qualities, however, that distinguished the former men of our service are necessary, only in a much higher degree, and a different training is required. What I advocate is the suiting of the training to the actual duties to be performed, so that the man at the wheel, or serving a gun, will be in complete accord with the officer directing the movements of the ship or the fire of the battery; will understand exactly what is required at any moment, and be, to use such an expression, a thinking portion of the machinery. This I hold the seaman of to-day in our service not to be, and I doubt the probability of any but a few of the old man-of-war's men ever becoming available under the new conditions that have grown up.

It is true enough that no officer would willingly go to sea, or into an action, with a crew composed of men whose whole training had been in a machine shop, with no experience of sea life; but, in my opinion, the ship that went into action with a crew composed entirely of the best topmen that ever went aloft, but with no knowledge of the machinery now used about the battery of a vessel of war, might be in even a more unfortunate position. I think a happy mean can be found in giving to all the essential men of the crew a mechanical training, and at the same time instructing them in certain details of handling sails and gear, manning boats, etc., that, I agree with Lieutenant Delehanty, will always be necessary at sea.

The suggestion of still continuing in service for training purposes the old sloops of war, but of fitting them with all modern appliances, is, I think, impracticable. The ships themselves are so entirely different from the modern types of war vessels, that the duty required of the crew can never be similar, and it is only by training men in the duties to be actually performed that any proficiency can be obtained. The "bewildering change" to a modern vessel of war for service would still be too great. In this connection, it must not be understood that I advocate a simple visit to a gun foundry, of a few hours occasionally, by a class of boys or men under instruction. I would have them attend closely the entire construction of a gun and its carriage, and require of them an accurate knowledge of all their parts and of their importance—a knowledge to be obtained only by close application for weeks, or possibly longer, but a knowledge that would be invaluable to them in service. After this preliminary instruction, the men showing especial aptitude for mechanical employments should be selected for actual work in the shops, to fit them for duty as armorers, in place of the gunners' mates and quarter-gunners we now have in the service.

The allusion of Commander Rodgers to the small percentage of the present apprentices who remain permanently in the service is worthy of serious attention, and furnishes a strong argument in favor of my proposal—to increase the

pay of enlisted men and give them other advantages they do not have now. Our present system educates, at great expense to the Government, a class of young men who can in the great majority of cases secure better positions out of the service than they can hope for in the Navy after serving out their apprenticeship, and this even in the present state of our carrying trade. It would seem to be better and more economical administration to seek to retain in the service young men who, from their training and experience, are just becoming of value on board our ships.

The necessity of increasing the pay of the skilled men who will be required to handle our guns in future, is emphasized by the fact that we have been compelled gradually to increase the pay of machinists, boilermakers, and other men of the engineer force on board our vessels, in order to secure competent and trustworthy men for those positions.

The CHAIRMAN.—*Gentlemen:*—No one will fail to agree in the proposition that a much higher degree of intelligence is required in the men who are to fill important stations at the guns to be carried by our modern vessels, than was needed to handle the old smooth-bore guns of the service. The character of all the drills on board ship will be entirely different, and this is an important point suggested by the paper just read. They will be so different, indeed, that no time should be lost in commencing the instruction and training of the men who are to serve in the new ships, if they are to be made efficient in all respects. Upon the rapidity and accuracy of fire of the few guns now carried by vessels of war will depend the fate of engagements either between fleets or single ships, and these qualities can only be obtained by constant, careful practice.

In speaking of seamanship as a necessity of the service, I do not understand the writer to disparage this by any means, but to insist upon a type of seamanship in accordance with the duties to be performed at the present day. Seamanship is simply a thorough, ready knowledge of the duties to be performed on board a vessel at sea. The most important duties of men on board a vessel of war are at the guns, and a knowledge of their character and power and appliances must take precedence of all else. It must not be forgotten that actions will never again be fought under sail, except under circumstances so exceptional that no foresight can provide for them, and that the tactical evolutions, which in the past required for their success the smart, alert topman aloft, and on deck, have given place to a new system of combinations under steam that precludes the use of sails. In the actions of the past, when a sheet or brace was carried away by an enemy's shot, the active, quick seaman was required aloft to replace it at once, even a moment's delay being in some cases enough to cause defeat; but now machinery has taken the place of gear, and the future man-of-war's man must know how to handle it, and to replace or repair it at need.

As to drills with spars and sails being an important means of discipline among the crew, it is true that any drills systematically carried on tend to that result; but it may be questioned whether better results cannot be obtained by drills that will have a direct bearing on the duties to be performed in action, rather than in expending time in evolutions that will never find a place hereafter in combats at sea.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL ASYLUM AND SERVICE PENSIONS FOR ENLISTED MEN.

By Lieutenant-Commander Chas. H. Stockton, U. S. N.

In presenting this paper upon the Naval Asylum, I wish to state that I was impelled to prepare it from the fact that so little is known of the Asylum and its workings. A very interesting historical sketch of its origin, and of the tract of land upon which it is situated, by Medical Director Edward Shippen, U. S. N., is the only printed matter upon the subject that I could find, outside of the usual references in the reports of the Chiefs of the Bureau of "Yards and Docks," and the still more meagre mention in the Acts of Congress.

By kind permission of Dr. Shippen, I have availed myself of some of the material contained in his pamphlet, and in addition I have drawn to a considerable extent from a manuscript sketch of the Asylum prepared by Commander Edward Hooker, U. S. N., a long time stationed at the Asylum, and whose services have been highly appreciated by the governors under whom he has served at that place. To both of these gentlemen I make my acknowledgments, and wish to express the hope that their labors will be generally appreciated.

In 1811 an act was passed by Congress establishing a Board of Commissioners of the Navy Pension Fund, who were also to be Commissioners of the Navy Hospitals. This Board was to consist of the Secretary of War, the Secretary of the Navy and the Secretary of the Treasury; and the act further authorized the above-named commissioners to acquire sites, buy and build hospitals for the naval service, and in addition to provide at one of the establishments a permanent asylum for disabled and decrepit navy officers, seamen and marines. In another section of the same act, the Secretary of the Navy is authorized and required to prepare the necessary rules and regulations for the government of this institution.

This act created the Naval Asylum now at Philadelphia, and, by the use of the word "Asylum," unfortunately gave it the name which it bears. Similar institutions of a later birth, for the regular and volunteer service of the Army, have had chosen for them the happier name of "Home," and it would be wise to adopt the same for the seamen's home of our service.

The legislation originating the Naval Asylum, as well as the Naval Hospital establishments, appears to have been directly traceable to a letter of the Honorable Paul Hamilton, then Secretary of the Navy, addressed to the House Committee on the Naval Establishment. This letter proposed many other matters for legislation, one being the establishment of a home or asylum for the widows and children of seamen killed in action, the sons of such seamen to be brought up for the naval service. Another proposition was for the instruction of the midshipmen of the service at one of these establishments—the first suggestion of a naval school that I know of in our naval history.

No immediate action appears to have been taken, after the passage of the act just mentioned, to found an asylum for the aged and disabled of the Navy; probably the war of 1812, so essentially naval in its character, fully occupied the administrative energy and resources of the Navy Department for the immediately succeeding period, and the subject passed away from the attention of the Department.

In 1826 a suburban estate near Philadelphia, known as the Plantation, and for many years a possession of the Pemberton family of that city, was purchased for hospital purposes. The price paid was $17,000, and the mansion of the estate was used for the hospital, abandoning the building formerly used for that purpose at the Navy Yard in Philadelphia.

About this time the question of the Asylum being revived, it was determined to erect, in accordance with the law, a large and permanent building for that purpose. Philadelphia was selected as the site for the Asylum; and it is stated that though it was not the intention at first to use the present site, or connect it with any hospital, still, after considerable discussion, the decision was finally made to use a portion of the Pemberton tract for that purpose.

I have not been able to find out the exact date of the commencement of the structure, but the appointment of Mr. William Strickland and Surgeon Thos. Harris, U. S. N., as commissioners for the erection, dates in 1827. Mr. Strickland was the architect, and Dr. Harris the surgeon in charge of the adjacent hospital, and afterwards chief of

the Bureau of "Medicine and Surgery" of the Navy Department. In 1832 the building was under roof. The grounds were then, as now, about twenty-three acres in extent, the original tract having, however, been modified in its boundary lines by sales and purchases, as well as by opening of streets and rectification of boundary lines. The jurisdiction over this property was ceded to the United States in the session of the Legislature of Pennsylvania held in 1832–33. Curiously enough, this cession was made in two sections of an act to abolish imprisonment for debt. The following year, April 15, 1834, an act was drawn up and passed making the cession in a more formal and deliberate manner, but including the proviso which reserved the right to serve all process, civil and criminal, of the Commonwealth of Pennsylvania; and furthermore directing that this cession should only continue in force so long as the territory should be used for the purposes of a United States Naval Asylum for sick and disabled seamen.

Up to 1832 the expense of construction was borne by the Hospital Fund of the Navy; but in that year a direct appropriation was made of $33,900 for completing the structure and furnishing one wing. In the same year, the Board of Commissioners of the Navy Pension, Privateer Pension, and Hospital Funds, was abolished, and the Secretary of the Navy was made sole commissioner or trustee for all of these funds, and so remains to the present day.

The Asylum building was occupied in the latter part of 1833, though appropriations of money still continued for the internal completion, continuation of work on the grounds, etc., until 1842. The entire cost of the building, excluding the finishing of the attics, was $195,600; about four-ninths of which came from the Treasury directly, the remainder from the Hospital Fund.

The building is an imposing structure of grayish-white marble, with a granite basement; it is 380 feet in length, and consists of a centre with a high, broad flight of stairs and large abutments and a marble colonnade and pediment. The wings of the building are symmetrical, and terminate in transverse buildings at each end. Verandas have been constructed in front of the wings, well covered, which, though of great convenience, are out of harmony with the classic style of the central structure and general design of the exterior. All of the ceilings of both basement and first floor are vaulted in solid masonry, and on the first floor is a fine domed apartment, used as a chapel and mustering room. The most faulty part of the structure is the base-

ment, which is somewhat low and damp, with insufficiently constructed sub-cellar and inadequate system of drainage. This is better now than when the building was first completed.

Each beneficiary is provided with a room, small in size and plainly furnished; this is often much improved in appearance by the individual occupant, in accordance with his tastes and circumstances. The privacy given by these small rooms, not much larger than state-rooms on board ship, is highly prized by the beneficiaries, and the additional independence and dignity given are of great value in fostering the sense of honorable retirement. In this feature the Asylum differs from the "Sailors' Snug Harbor" and the various soldiers' homes, and in a measure it compensates for the greater privileges and advantages offered by the latter. Besides these rooms, there are reading and smoking rooms in the transverse buildings, and quarters for officers and employees.

The first beneficiary (the official designation of an inmate) was admitted as such in 1834, Lieutenant James B. Cooper, U. S. N., having been detailed as superintendent of the Asylum during the month of April of that year. Before the end of the year, five others were admitted, and from this time forth the Asylum was duly in operation under the law.

A part of the Asylum building was designated as a general-service hospital from its first occupancy, and the southern portion continued to be used for such purposes until 1868, when the new general-hospital building in the same grounds was occupied, and the Asylum building used solely for its original purpose. During the Civil War, the number of sick and wounded being so great, all available space was used for hospital purposes, the necessities of the times obliging the Secretary of the Navy to so order it.

Up to 1858, though direct appropriations were made for repairs, improvements and other items of expense, the cost of the maintenance of the beneficiaries was defrayed from the Hospital Fund, until the growth of the Asylum and consequent increase of cost made too great a tax upon that fund. The Asylum then began to take the position of a separate establishment, and very justly, in that year, provision for the support of the beneficiaries was made in the Naval Appropriation Act. Since then annual naval appropriation bills have contained items for the support of the beneficiaries, pay of employees, and for repairs, care and improvement of the grounds and buildings. In 1869 the money for most of these purposes was directed to be

paid from the income of the Navy Pension Fund, and in 1873 it was directed that all expenditures for the Asylum should come from that source as duly appropriated by law.

As the inmates increased in the Naval Asylum, the want of proper organization, internal conveniences, and means of enforcing discipline, led to many reports and complaints on the part of the superintendent, Lieutenant Cooper, and complaints were also made by others to the Department. Lieutenant Cooper stated to the Secretary of the Navy that, from want of proper subordinates, he had been forced to assume a variety of duties, from superintendent to Master-at-Arms and cell-keeper. The attention of the Secretary was finally attracted, and Secretary Paulding, deeming a change desirable, wrote to Commodore James Biddle, offering him the charge of the institution, with, it is presumed, enlarged powers and the title of governor. The command of the Asylum was accepted by Commodore Biddle, and the official title then given to the commanding officer remains to the present time. The Asylum, which had been under the general jurisdiction of the Navy Yard up to the accession of Commodore Biddle, was then separated and created an independent command.

In 1839 a naval school was established at the Asylum; the building then containing three different institutions, the Asylum, the Hospital, and the Naval School. The first class ordered to the Asylum consisted of eleven midshipmen, all of whom had been for some time in the service. The numbers in attendance increased, and, with this increase, additional facilities for instruction became necessary, and were partly provided, until the school outgrew its accommodations (which were never suitable at the best), and finally, in the summer of 1845, it was removed to Annapolis, Md., at which place, and at Newport, it developed into the present fine institution, with its more than national reputation.

The Asylum was placed under the charge of the Bureau of "Yards and Docks" in 1849, then having Rear Admiral Joseph Smith as its Chief, and under his supervision great administrative improvement was made. The Asylum has continued under the cognizance of that Bureau until the present day. In the Deficiency Appropriation Act, approved March 14, 1864, was an item giving $75,000 for the extension of the Naval Asylum, and the following year, in the regular appropriation bill, was a clause which provided the sum of $100,000 to enlarge "the accommodation for sick, wounded and *otherwise disabled*" at the Naval Asylum, authorized by Act of Congress, March, 1864.

By these appropriations, $175,000 in all, the Naval General Hospital within the Asylum grounds was erected; and thus, under the shelter of the enlargement of the Asylum, whether intentionally or not, the Hospital Fund and establishment of the Navy has received back the money spent for the Asylum building and purposes. In addition, the use of a large portion of the building for general hospital purposes and the proceeds of several sales of portions of the original tract have repaid the fund for the purchase of the grounds.

Since the removal of the Hospital establishment from the Asylum building, the available space for beneficiaries has been gradually taken up, the increase being steady but slow, until now it is necessary to quarter the men in the basement and attic, both unsuitable in the warm weather. Recently, when quarters originally designed for officers were vacated on the second floor by the detachment of an officer, the vacant apartments were subdivided into smaller rooms for the use of the beneficiaries, in answer to the demands for additional space.

On the 1st day of January, 1886, there were at the Asylum:

On the rolls,	207	Beneficiaries.
On leave of absence,	20	"
Under suspension,	4	"
In the Hospital,	14	"

Remaining under the Asylum roof, 169 beneficiaries.

In addition to the above, there were at that time fifty-one (51) marines and civilian employees quartered in the building, making 220 living there, exclusive of the officers, their families and attendants.

It will be observed that fourteen were in the Hospital; this refers to the General Hospital previously mentioned, the total number of patients from all sources being nineteen. It can be seen that the Hospital is really more of a hospital for the Asylum than for the service at large, over seventy per centum being from the Asylum. A large proportion of these are naturally men sent there on account of extreme old age, helplessness, and for purposes of special diet, making the Hospital to a certain extent an infirmary. As a matter of fact, there is an apartment there for the very old and childish which is known as the Nursery.

The Asylum is now under the command of Commodore Bancroft Gherardi, U. S. N., who as governor, by a considerate course of administration, makes of the institution as comfortable a home as the inconveniences of position, crowded conditions and antiquated state of the building and its appliances will allow.

The dining-room being in the basement, the aged men who are quartered in the attic are obliged to ascend and descend three flights of stairs three times a day, and there are many elements of danger in this height and stairway in case of fire. In other respects, also, the building is not of suitable design for its purpose. The attics, though large, and improved from time to time, especially under the administration of Admiral Rhind, are too low and hot in the summer. The dining-room is not in the proper place, and the kitchen and laundry arrangements are old and inadequate.

The food supplied is excellent in quality and quantity, and if the table is lacking in any way, it is due to the defective cooking arrangements and to the limited number of cooks and waitresses allowed by law. A remedy for this and other defects has been set forth in the report of Commodore D. B. Harmony, to the Secretary of the Navy, as Chief of the Bureau of "Yards and Docks."

The allowance of clothing is ample in quantity, reasonable in cost, and good in quality. The question of some change is now being considered, to give a greater variety in the allowance without any increased cost.

No attempt is made to place the institution upon a strictly military or naval basis, but to provide a home for the disabled and decrepit, and to give the greatest latitude consistent with cleanliness, good order and administration. All are allowed leave to go and come, unless the privilege is forfeited by bad conduct. The reading-rooms and library are provided with a good collection of books, and the Bureau subscribes to daily and weekly journals and magazines for the benefit of the inmates. The chapel services are enlivened by music paid for by the Asylum.

A small number of men are rated and classed as petty officers and attendants, and do duty as such, receiving an allowance of pay for their services; the allowance for the other beneficiaries for pocket-money is one dollar per month. A small increase of this meagre allowance is and has been asked for by the various Chiefs of the Bureau. A more liberal allowance is needed in this and some other matters. As usual with all naval institutions and men, the comparison with similar institutions and privileges of the Army shows the better treatment of the latter branch of the service; and in the matter of pensions and money, the inmates of the soldiers' homes fare better, notwithstanding that the requirements for admission to the Asylum are far more rigid. The most prominent instance of this is the surrender

of the pensions of the pensioned inmates to the Hospital Fund of the Navy. This custom, for there is no law requiring it, originated when the Asylum was supported by the Hospital Fund; but this support has long since ceased, the original force of the custom alone continuing the practice. The assignment of the surrendered pensions to the pensioners direct is not advocated, as, with so many wants supplied, and with the habits of drunkenness formed in the service, the money in many cases will be quickly squandered; but as the Government stands in the place of guardian, the pensions could be assigned to the credit of the Asylum, to be expended, under the supervision of the Bureau, for the increase of pocket-money to a limited extent, and to the further provision of comforts to the aged and enfeebled, such as special diet, spectacles and artificial teeth, etc., for those needing them, and additional amusements, entertainments and music for all of the beneficiaries.

Many applicants for permits are stationed or residing at a long distance from Philadelphia, some as far as California, and these men, when granted admission, are often entirely without the means to take them to the Asylum; and as there are no funds available for that purpose, the permit is either refused, or the charity of others invoked. A small amount, if duly appropriated and carefully expended, would remedy this, and prevent the successful applicant from a dependence upon private charity for his travelling expenses to Philadelphia, or looking upon his permit as a hollow mockery.

The pensioner should also have the privilege, now existing and sanctioned by law in the soldiers' homes, of surrendering his pension to his *dependent* wife, child, or parent during his stay in the Asylum. To this, if carefully supervised, there seems to be no serious objection on the score of justice or expediency.

These suggestions of increased liberality of treatment may seem too generous to some; but when it is considered that these men became disabled and worn out in the service of the country, without means of acquiring a support for themselves in their old age, and further, that the money proposed to be additionally expended either comes from their own pensions, duly surrendered, or from the income of the Navy Pension Fund, from which they are supported, it seems not charity, but justice. The Navy Pension Fund, itself in greater part created by the exertions of the officers and men of the naval service, is sacredly set aside by law for the payment of pensions, and for the care and comfort of disabled officers, seamen and marines of the Navy.

I will mention here, in addition to the above, that there are a number of men who have served in the Navy alone, during the war, who are now inmates of the volunteer soldiers' homes. They should be, if proper objects of the care of the Government, at the Naval Asylum; and as it is the fewer privileges and the want of room at the Asylum which both lessen the attractions and limit the entries there, both of these defects should be remedied, and the soldiers' homes relieved of the unwelcomed care of our own beneficiaries.

Under Section 4811 of the Revised Statutes, the rules and regulations governing the Asylum are prescribed by the Secretary of the Navy. Under his direction, this was done at first by Commodore Biddle and afterwards by Admiral Smith in 1849 and 1851; afterwards the regulations were revised and incorporated in the Navy regulation books of 1870 and 1876, those given in the last-named book being the ones now in force, though much in need of further revision.

The present requirement for admission is twenty years of service, accompanied with a certificate from a naval surgeon that the applicant is unable to support himself by manual labor. In extraordinary cases, and by the written permission of the Secretary of the Navy, this rule of service can be waived, and a disabled man of less service admitted. Hence, a man having less than twenty years of service, no matter how badly disabled by wounds, disease or exposure in the line of duty, can only be admitted as an exceptional case. This is certainly neither just nor generous, and though the present space would not, at this moment, allow the practice of a more liberal requirement, still, simple justice should at once enlarge the present requirements for admission, as well as the available accommodations at the Asylum.

Various questions have arisen and suggestions been made in regard to the Asylum and its existence, which can be narrowed down to three propositions:

1. The advisability of the abolition of the Asylum.
2. The enlargement of the Asylum on its present site.
3. The removal to another site, with larger buildings, increased facilities and ampler surroundings.

Taking up, first, the proposition, urged by some, to abolish the Asylum and to follow the example set by the English government, which was to break up the Greenwich Hospital as an Asylum for pensioners, disperse the inmates, and substitute a pension for those able to provide homes for themselves, and to place the sick and very helpless in the various service hospitals and infirmaries. There seems to be no reason why we should follow this example.

The Naval Asylum was established for disabled and decrepit navy officers, seamen and marines; and the regulations for admission prescribe that the disability should be so great as to prevent the inmate from supporting himself. Here, then, is the actual need which the Asylum meets, and for which it should exist. By law, out-door relief is already provided by pensions given, in Sections 4756 and 4757 of the Revised Statutes, to those desiring them in lieu of the home in the Naval Asylum. If this should be supplemented by legislation giving the seamen of the Navy the same retired list and pay which has been already provided for the Army and Marine Corps after thirty years of service, the system of out-door relief for the veterans and disabled would be complete. The question of pensions to those who serve twenty years and leave the service in a good physical condition, is a question which pertains to the general question of naval reserve, defence, and inducements for the retention of trained men, and will not be discussed here.

As a humanitarian need, and as a matter of justice towards those who give up their life and health to the service, the Asylum should exist. There is no class of men who are so helpless on shore, even when in health and vigor, as seamen; and the restless, roving nature of their occupation makes them more peculiarly helpless in old age and disability. They have been so universally victims of the baser elements of mankind that prey upon them in our seaports, that governmental and philanthropic means have been provided for their protection and care while in the prime and vigor of their life and while in the most active pursuit of their calling. If "Rests" and "Homes" are needed then, how much more urgently are they needed in their later life, when their earlier habits are more indelibly fixed and the care more imperatively needed! Though this state of partial vagabondage is far from being an ideal one, still, all who have studied the question know that it is real.

Considering the question from an economical aspect, the following statements can be made:

In the fiscal year 1884–1885, the average cost of a beneficiary, charging all expenditures, such as subsistence, clothing, pocket-money, pay and subsistence of employees, allowances, care and repair of buildings and grounds, cemetery expenses, etc., but excluding pay of the naval officers stationed there, was $286.26. For subsistence, clothing, pay and tobacco alone, it was $164.78. This does not include the cost of the building and grounds or the interest of money

expended for both. It excepts the Asylum and its grounds as an established expenditure.

Section 4756 of the Revised Statutes provides that "there shall be paid out of the Naval Pension Fund to every person who from age or infirmity is disabled from sea-service, but who has served as an enlisted person in the Navy or Marine Corps for the period of twenty years, and not been discharged for misconduct, in lieu of being provided with a house at the Naval Asylum, Philadelphia, if he so elects, a sum equal to one-half pay of his rating at the time he was discharged," etc., etc.

With the present rates of pay, and without considering the question of increased pay by continuous service, the pension for out-door relief, under the above law and with the pay now prescribed, following the classification as shown in the Navy Register, would be:

For petty officers of the			1st	class,	from	$210	to	$420.
"	"	"	2d	"	"	161	"	360.
"	"	"	3d	"	"	162	"	240.
" seamen and others of all classes,					.	96	"	210.

After a service of twenty years, the most deserving men would be holding the rate and increased pay of petty officers, the less deserving would be seamen, etc., and the least efficient of all would be in the lower grades. Good and efficient service is thus rewarded in the present system of out-door relief or service pension, and the compensation in the majority of deserving cases is greater than the average cost of the support of a beneficiary, $286.26. As the number in the Asylum increases, the average cost of support naturally lessens, and there is no doubt in my mind that the inmates receive more material comforts, better care, and more generous allowances, at a less cost than would be possible were the same amount of money expended separately on each one. A proof of that is the comparatively large proportion of inmates who are pensioners and who surrender pensions to enter the Asylum. As a matter of justice, humanity and economy, then, I think the Asylum should continue.

Granting the continuance of the Asylum, with or without more liberal provisions for entrance, the question of enlargement is an urgent one. The Asylum is now about full, as stated before, and if those in the Hospital and on leave were to return to the Asylum, there would not be places for all of them in the building. The quarters in the basement and attics are unfit in certain seasons for their purpose,

and men have to climb up and down stairs who, from their physical condition, ought not to be compelled to do so.

There are several officers quartered in the Asylum building, as the governor's and surgeon's residences are the only ones outside the main building. Valuable space is necessarily taken in this way in the second and third floors and in the basement. The marines, the male and female employees and the servants of the officers, are also quartered in the building; the female employees being separated by a lattice door only from the beneficiaries, and all having to use the corridors and stairways in common.

In addition to the steady increase, those men who entered the Navy at the urgent call of the country, and who remained in the service, are now eligible to the Asylum, and require accommodation. They cannot be refused; nor is it intended by Congress, in its well-known liberality, that the soldiers and sailors of our late war should be excluded. Temporary means of enlargement have been suggested in various reports by the different chiefs of the Bureau—among others, the use of part of the adjacent General Hospital, but a limited portion of which is occupied for hospital purposes. These means will probably have to be availed of in the course of time; but they are but makeshifts, and serve to postpone the inevitable and systematic enlargement or removal. The present Asylum building is inconvenient in its arrangement, height, and general style of architecture, and not well adapted for its purpose, and hence an extension of that building would be but a partial remedy.

The truth is that the site at Philadelphia is unsuitable. Situated as it is in the midst of a large city, overlooking what once was a beautiful stream, but which is now not more than a canal; its water-front used for the reception and discharge of manure; surrounded by streets; its grounds to be invaded by a railroad, and the neighborhood none of the best, it is quite time the naval and seamen's retreat should be moved to a better place and near more suitable surroundings. Facing the Asylum, on the opposite bank of the river, is the Blockley Almshouse of the city of Philadelphia, and the juxtaposition of the two institutions has led to the derisive cry of "Government paupers" being addressed to honorably retired men of our service by some of the denizens of the neighborhood. Though the position of the Asylum affords various conveniences, and many of the beneficiaries have formed attachments and associations which would lead them to regret at first the change from Philadelphia, still, a comfortable home

near the sea, in a mild climate, within sight of the active movements of shipping, would soon reconcile them to the change, and would awaken a sentiment most healthy and desirable. If added to this were opportunities afforded for out-door amusements and occupations, such as boating, fishing, bathing and kindred recreations, the artificial and injurious attractions of a large city would speedily be counterbalanced.

In consideration of the above disadvantages of the present situation of the Asylum, the advantages of a seaside position in a mild climate, and the further urgent necessity for a proper and systematic enlargement of the buildings and facilities of the Asylum, involving almost a complete reconstruction, it would in every way be advisable to make a complete removal and construct needed buildings, carefully designed for their special purposes, fitted with the latest and most modern appliances, and with ample surrounding space and water-front. No place seems to meet more fully all the requirements for the new site of the Naval Asylum, as stated, than the vicinity of Hampton Roads and Newport News. Central in its position on our Atlantic coast, with an abundance of water-front, protected from sea and wind, having ample facilities for boating and fishing, with mild and equable climate, near the best markets in the country, in proximity to the cities of Norfolk, Richmond, Washington, and Baltimore, and in ready communication with all by boat and rail, I know of no other place so suitable in all its advantages. Farther north the severity of the climate is objectionable on account of the age and enfeebled condition of a majority of the beneficiaries. Farther south the possibility of malarial and other fevers would present disadvantages.

To an extent, Hampton Roads and Fortress Monroe are both naval and military rendezvous, and the movements of naval vessels and the sight of military life would be congenial to both the aged seamen and marines. The fact of the presence of the Branch Volunteer Soldiers' Home, while proving the availability of the site, would be unobjectionable, and its popularity as a home, both among our soldiers and sailors, shows that the change would end in being a most grateful and acceptable one to those immediately concerned.

The comparative cheapness of the land in that vicinity would allow the purchase of a large tract, portions of which could be used for farm purposes, furnishing milk, fruit and vegetables in abundance; and the sale of the present site, valuable for building purposes, ought to reimburse the Government for the expense incurred for the pur-

chase of ground, construction of the necessary buildings, and the expenses of removal. Care should be taken, though, that the old buildings should not be given up until the new are fully ready for occupancy.

In addition to the material advantages presented by a site at Hampton Roads, the historical associations, traditions and sentiment of that vicinity should not be ignored. In the war of the Revolution, in the war of 1812, and in our late Civil War, most prominent scenes in the historical drama were there acted. Yorktown, Craney Island, and the engagements of the Merrimac, ending in the duel of the iron-clads, are all associations of that vicinity, and many actors in these latter scenes could, while ending their days quietly in the Naval Home, fight over again those grand engagements of the Cumberland, the Merrimac and the Monitor, the world-wide glory of which is so evenly distributed between the contending forces of the North and South.

Statistics of Naval Asylum, 1885.

Number of men on rolls January 1, 1885,		199
Admissions during year,		22
Re-admissions during year,		4
Total,		225
Died during year,	12	
Dropped,	3	
Dismissed,	3	
Decrease,		18
Remaining on rolls January 1, 1886,		207
Number of blue-jackets,		143
Number of marines		63
Late Lieutenant U. S. N.,		1
		207
Number having 20 years and more of service,		147
Under 20 years,		60
		207

Average age of inmates,	64.05 years.
Oldest inmate,	97 "
Youngest inmate,	40 "

Number of pensioners on rolls, ... 98
Pensions varying from $4 to $24 monthly.

Nativity of Beneficiaries.

United States,	103	West Indies,	2
Ireland,	59	Finland,	2
Germany,	14	Italy,	1
Scotland,	8	Belgium,	1
England,	6	Wales,	1
Sweden,	3	Norway,	1
Denmark,	3	Nova Scotia,	1
Canada,	2		

NAVAL INSTITUTE, ANNAPOLIS, MD.

THE CASE OF THE MIGNONETTE.

By Henry Winthrop Hardon, A. M., LL. B.,

Law Orator for 1885, Harvard University.

There was presented in December, 1884, for decision in an English Court of Appeal a case absolutely without precedent in the English law. It was a case of peculiar interest, for though an English court had never been called to pass upon it, the question was one which had been discussed by casuists since Cicero's time, and once by Grotius, the founder of international law, and once by a great English Chancellor, Lord Bacon, and always with the same result. The case involved the death penalty, and Lord Chief Justice Coleridge, reaching a new conclusion, sentenced the prisoners to be hanged. This decision suggests an inquiry into the theory of criminal punishment in the English and American law.

The facts in the case were briefly these:

The Mignonette, an English yacht of nineteen tons, foundered at sea in the South Atlantic, during a severe storm, on the 5th of July, 1884. She was then on a voyage out from Southampton, bound for Australia, in charge of a captain and crew of three. In view of the events which subsequently occurred, it is important to state that Dudley, the captain, was a man of exemplary character, and a sailor of great experience. Such was his reputation wherever he was known. The rest of the crew were two men, and a boy, named Parker, eighteen years old.

The captain and crew got safely to their boat when the yacht went down. They had had no time to secure any water, and their only provision was a mere handful of food the captain had saved. They were sixteen hundred miles from the Cape of Good Hope. The small stock of food was quickly exhausted, and then, until the event which took place on their twentieth day in the small boat, they had nothing more to eat.

On the sixteenth day the boy Parker had drunk sea water and become delirious; he lay afterwards helpless in the bottom of the boat. The three men had then become almost exhausted from their long privation, and were tortured with thirst. Their prospect of immediate rescue seemed slight. Their only hope for longer life lay in the sacrifice of one of their number. They must resort to this dreadful extremity or die. Dudley suggested that they should draw lots; but neither of the other men would agree to this, and the boy no longer comprehended what was said. Dudley then proposed that they should sacrifice the boy. From his condition it was clear that he had the shortest time to live. All must die unless they had speedy relief; their situation was desperate. It was finally agreed that, if there should be nothing in sight at sunrise and no rain came, the boy should be killed. At eight in the morning there was no sail to be seen and no rain. After a solemn and prayerful deliberation, Dudley bent over the boy and told him his time had come. He made no answer, and while the mate held the boy's feet, Dudley opened a vein in his neck with the blade of a penknife. There was no struggle, and all was over in fifteen seconds.

Five days later a German bark rescued the three men. They were then in a state of complete exhaustion; there was little flesh on their bones, and, whether sitting or lying down, they were continually in great pain.

On reaching the first English port, they went at once to a magistrate and made a statement about the wreck and subsequent occurrences, concealing nothing. They were immediately arrested, and shortly tried for murder. The jury found that all would have died before the rescue if the boy had not been killed. Their sympathies were warmly enlisted in the prisoners' behalf, and acting upon a suggestion of the judge, they adopted a very unusual course and brought in a special verdict, in which, after stating the facts, they declared that they were ignorant whether or not the prisoners were guilty of murder. A case was thus presented for the judges.

It is very clear that the act is embraced within the received definition of murder, and no previous case had established an exception upon such facts as these. The counsel for the defence pleaded that the homicide was justifiable on the ground of necessity, and thus, for the first time in the history of the English law, the validity of the defence of necessity in such a case as this was presented for judicial determination.

That necessity of a certain sort is a sufficient justification for an act which would otherwise be murder, was not denied. If a highwayman assault a traveler upon the road, and the latter, in seeking to escape and defend himself, kill his assailant, the homicide is excusable on the ground of necessity. If the boy Parker, immediately before the knife reached his neck, and in order to save his own life, had by any means succeeded in killing Dudley, the homicide would have been excusable on the ground of necessity. Manifestly, the necessity which would justify Parker in taking the life of his assailant is of a very different sort from the necessity which would justify Dudley in making the assault, and if one be recognized as a legally sufficient necessity and the other be not, it is a dangerous legal equivocation to describe both sorts by the same word. It merely adds confusion to the Mignonette case to describe it by the term which the defence applied to it. Necessity, as previously defined in the law of homicide, has a fixed legal character, and should not be tampered with.

In order to describe the case in terms which shall defy the possibility of misunderstanding and yet be descriptively true, it may be called a case of prudent self-preference. Obviously, it is very like the case of the man who steals bread to save himself from starving. The law is very clear that such a stealing is not to be excused on that ground. The Lord Chief Justice remarked this analogy, and, arguing from the extreme case to the less extreme, refused to admit a new exception to the received definition of murder, and sentenced the prisoners to death.

With all deference, I may say that the Court has not exhausted the subject of this case when it has remarked an analogy which exists between it and a case of larceny, even when they have added to this the argument of expediency. There is nothing so well calculated to mislead as an analogy, and the argument of expediency should be resorted to only as an *ultima ratio.* In the words of Lord Eldon, "It appears to me to be necessary, in deciding this case, to be well informed of the principle upon which the question turns."

What is the principle upon which this question turns? Clearly it turns upon the principle of the criminal jurisdiction in cases of murder—upon the theory of criminal punishment. What, then, is the theory of criminal punishment?

This is a difficult matter. The question has been answered in several different ways—in five, at least—but the main controversy lies between two of them. The first of these may be called the absolute

theory. It is Kant's and Hegel's. Kant tells us that there is an "eternal fitness" in punishment; so great is this, that if society were about to disband and had in its prison a criminal tried and condemned, it would be a fitting act to execute him before the social dissolution. Expressed in Hegel's mathematical form, the proposition is that wrong is the negation of right, and punishment being the negation of wrong, if the punishment equal the wrong and the two negations balance, then the positive right is again established. It is contended for this theory that it furnishes an absolute standard for punishment, and does not leave it to the subjective determination of the judge.

There is a sufficient answer to all this. The theory advanced is ethic rather than civic or politic; and it is ethic of that school known as ideal. Hegel so understood it himself, and he proposed to draw the civic up to the ethic and make them one. But, as the theory stands, it is in professed contradiction to the actual state of the law. Courts have neither the time nor the means to undertake inquiries into the questions which this theory properly raises. The law cannot attempt to punish every morally wrong act—not every selfish act, even though the consequence of the selfishness has been a loss of life to others.

Suppose the case of a sinking vessel. A passenger manages to get alone into a boat which would hold half a dozen and pushes off alone, regardless of the cries of five others, who are thus deprived of their only means of safety. The single passenger has exercised a prudent self-preference, but I think the law could not interfere. Suppose there are already six in the small boat, and before it pushes off from the sinking vessel a seventh jumps in and so swamps it, and four of the original six are lost. The latter is a case of frequent occurrence, but no one ever heard of a court's attempting to take jurisdiction over it. The ethical problem is more complex than in the former case, while the loss of life is more directly the consequence of the act in question; but both cases are equally beyond the limit of the law. Finally, put the case where the boat contained seven, but cannot long live in the sea with such a freight, and one voluntarily jumps overboard and goes down. We recognize such an act as one of distinct heroism. Ethically, it is measured as worthy of all praise—an act to be enforced by every sanction. Legally, it is not measured at all: it is beyond the measure of the law. This absolute theory of Hegel's, then, does not fit the criminal law as we find it: the criminal law is not yet an ethical system of an ideal type.

It remains to examine the second theory of criminal punishment. It has been characterized in contradistinction to the former as a relative theory. It is that the end of criminal punishment is the prevention of crime. The guilty man is punished that others may see and tremble. This explains the grosser forms of criminal punishment—stocks and whipping-posts and public executions and the exposure of criminals' heads at Temple Bar. The severity of the punishment aimed at frightening others from wrong.

This theory has been objected to as immoral, because it treats the criminal as a thing in punishing him not solely for his own act, but for the crimes that others may commit in the future; and because in so doing it disregards the fundamental principle of free communities that all men are entitled to equal rights and liberties. To the first objection it is to be answered that, whether it be immoral or not to treat a man as a thing, this is precisely what the State does in common practice. It needs only to cite the case of the conscript driven off to battle at the point of the bayonet, to make this sufficiently clear. With reference to the maxim of equality, it is to be observed that, however the equation may stand between two members of a community, it no longer serves when one is added to either side; and if the community be a mere aggregate, then, though it consist of only three persons, the rights of any two of them are greater than those of the third. If a community be not a mere aggregate, but a new entity, then, too, as between the individual and the community, the equation has no application, for the two are in their nature incomparable.

The end, then, of criminal punishment is to prevent the commission of further crime, and the State, by means of the criminal jurisdiction, will punish a murderer that other murders may not be committed. Such is the commonly accepted theory of criminal punishment.

There is, however, a limitation upon this theory. If the object of criminal punishment is the prevention of crime, obviously the evil which the punishment inflicts upon the wrongdoer must be greater than the advantage he derives from the wrongful act, or else the punishment will not prevent the commission of other similar wrongful acts. If the larceny of a hundred-dollar horse be punished by a fine of only five dollars, the punishment will not go far to dissuade the evil-minded in the community from the practice of horse-stealing.

If it shall be found that, in a certain class of cases, the evil which the State can inflict cannot overbalance the advantage which the wrongdoer gains from his act, then, plainly, the criminal law has

reached its limitation, and an attempt to punish in such a class of cases will be simply abortive. The State will not succeed in preventing the commission of similar wrongful acts. Does not the Mignonette case stand for just such a class? Plainly, a present death by starvation is a greater ill than the possibility of a future death; and the latter is the utmost that the law can threaten.

This consideration is not new. It was urged by Macaulay when he sat in the Commission to frame the Indian Penal Code. It seems to be of the very essence of the Criminal Law. It is a fundamental principle in the philosophy of conduct that right action is induced and maintained only by enforcing adequate sanctions. The law knows no sanction but physical punishment, or its modification, the money penalty, and in the nature of things it could enforce no other. Where this sanction is inadequate, the law must fail to achieve its end, and any attempt to assert jurisdiction must be futile. Thus we are quite prepared to find—and such is the fact—that the new German Code provides no penalty for such a case as that of the Mignonette.

The conclusion is inevitable that the case is beyond the limit of the law—beyond the point to which the law can reach. No punishment the law can threaten or inflict will prevent a recurrence of the act under similar circumstances. The courts, then, should not attempt to exercise jurisdiction.

To the mind of the English Court the act was murder—murder reduced to its lowest terms, perhaps; murder to satisfy no personal spite nor spirit of malice; murder in dire extremity, and committed by a good man in a manner as painless as possible, but still murder, well-reasoned, deliberate murder. In this view, there was no course for the Court but to sentence the prisoners to pay the penalty provided in such case, and that penalty was death.

It may be urged that it is the function of the pardoning power of a government to afford relief from unjust, or excessive punishment. This is unquestionably true, but has no application to the present case. The sentence was not unjust, if any court has jurisdiction to pronounce it; nor was it excessive, for the punishment was the only one provided for a deliberate killing. If it is once assumed that the Court has jurisdiction to deal with the case, then there is no ground for the exercise of the pardoning power; and if the accused are to be sentenced and then immediately pardoned, the State virtually says in the same instant: "These men are and are not guilty of murder." The inconsistency is glaring, but the course is that

which was actually adopted in the case, for, at the suggestion of the Lord Chief Justice and the Home Secretary, the death sentence was commuted by the Queen to imprisonment for six months.

We may agree with the final result, but the means by which it was reached are fairly open to criticism. The Mignonette case was not a case of murder. It was not a case of murder, because it could not be dealt with as all cases of murder can be dealt with. It is not properly within the criminal jurisdiction, and the English Court would have acted in a manner consistent with sound legal principle if, on becoming aware of the facts, it had refused to go further in the case.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVY SIX-INCH B. L. R.

By Ensign T. S. Rodgers, U. S. N.

(By permission of the Bureau of Ordnance.)

In 1881 the Bureau of Ordnance of the United States Navy decided on the construction of steel breech-loading rifled high-power guns for the Navy, in such quantities as Congress should see fit to appropriate money for.*

In September, 1881, bids were requested from fifteen steel firms to furnish the steel for a 6-inch gun. The only two firms that responded were the Midvale Steel Works of Nicetown, Pa., and Park Brothers of Pittsburgh. For various reasons, the other firms all declined to compete for this contract. In April, 1882, an order was given to Park Brothers for a tube, jacket, and breech plug. After various experiments, and attempts and failures, they offered these pieces for inspection in May, 1884. The tube and jacket were rejected, but the plug was accepted, and the rest of the order cancelled. In June, 1882, a contract was made with the Midvale Steel Works for the material of two guns, and at various times since new contracts have been made with this firm, and they have supplied all the steel used in the manufacture of the 6-inch guns.

The first order was for one heavy and one light gun, the former to be wire-wound and the latter hooped. The price of the steel was fixed at so much per pound, the weight of the rough-forged, unbored tubes and jackets, and the rough-forged hoops, to be taken as the basis of payment. It was agreed that the company should take back the steel waste at so much per pound, and should furnish the Bureau test bars at a fixed price per bar.

* One 6-inch low-power gun, known as the "South Boston Gun," had previously been made.

Tests of Metal in Guns Nos. 1 and 18.

Part of Gun.	Tensile Strength.		Elastic Limit.		Elongation after Fracture.		Reduction of Area after Fracture.		
	No. 1.	No. 18.	No. 1.	No. 18.	No. 1.	No. 18.	No. 1.	No. 18.	
Tube.	74,768	84,530	29,833	42,149	28.52	23.87	39.41	46.05	
Jacket	75,000	88,300	34,065	44,200	27.58	22.80	42.23	38.50	
A	102,267	116,700	44,733	68,700	18.48	14.92	26.79	25.90	
A	88,465		39,810		25.53		37.41		
A	93,733	121,769	41,235	68,980	23.71	15.95	36.72	31.05	
A	86,436		41,030		29.40		45.60		
A	91,523	108,112	52,337	63,025		15.20		29.18	
A	94,607		49,553		18.67		28.35		
A	90,799	107,543	41,694	59,854	23.30	16.45	32.37	32.65	
A	109,881		44,117		12.32		12.31		
B	107,314	101,672	46,297	53,618	18.17	16.70	24.19	29.20	A″ in No. 1.
C	93,030	99,608	33,104	54,932	16.45	17.42	21.16	39.36	A′ "
D	93,956	103,297	49,569	53,287	25.51	16.42	37.78	29.56	B "
E	110,574	102,700	44,896	55,200	15.13	17.30	18.73	33.10	C_1 "
	102,880		44,727		18.90		26.49		C_2 "
F	88,555	119,738	29,254	62,631	22.36	18.05	32.59	35.26	D_1 "
G	101,879	103,171	42,755	61,148	17.20	17.77	20.90	36.61	D_2 "
Tr.	82,501	81,191	45,701	41,600	12.30	12.10	22.00	13.32	

The steel for No. 1 is annealed, and for No. 18 annealed and oil-tempered.

Starting in with but little experience in this kind of work, but with a determination to do good work for, and to build up a business with, the Government, the Midvale Company has from the first been successful, and has gradually improved its processes until it has now reached a point where it can turn out with comparative certainty steel for this calibre as good as can be got in any market of the world. A look at the appended table, giving the tests of metal for the No. 1 and No. 18 guns, the first and last of the finished guns, will show a very great improvement in three important particulars: (1) in elastic strength, (2) the ratio of the elastic strength to the tensile strength, and (3) the uniformity of all the characteristics, especially the elongation and reduction of area.

I shall now go through the process of manufacture of the guns as now practised, noting the changes that have been made since the first gun (the only one which has been thoroughly tested), and first explaining briefly the design of the gun.

The design for Mark I. was made in 1881, and that for Mark II. in 1884. A sketch of the latter is appended. From this it will be seen that a tube extends the whole length of the bore. A jacket fits over the breech end of the tube and holds the breech plug. The trans-

verse strain is borne by the tube, jacket and hoops combined; the jacket and hoops being given an initial tension by being shrunk on. The amount of shrinkage is based on the actual characteristics of the metal, and is calculated so that for a certain internal pressure each of the three parts shall work at its elastic limit. The strength wall at the various points, and the shrinkages of the several pieces, were worked out by Virgile's formulae, the former being traced on the sketch. The longitudinal strain is taken up by the jacket, aided by the locking and trunnion hoops, and by the friction between the jacket and the tube and hoops caused by the shrinkage. This last is of course very considerable, but the jacket is made more than strong enough to bear any longitudinal strain that could possibly be put upon it. The jacket and *B* hoop being put on from the rear up against shoulders, and the *C* and *D* hoops in the same way from the front, the tube, jacket and these hoops are locked securely together by the trunnion hoop, which is screwed on. By this method it is also assured that the gun may not shake loose through much firing, and be driven to the rear through the trunnion hoop. The bore is thirty calibres long, and its total capacity is 5604 cubic inches. The capacity of the chamber is 1414 cubic inches, making the number of expansion 3.96. The cone between the chamber and bore is made long, to prevent the erosion caused by the gas rushing against a shoulder made by a sudden change in diameter. The various dimensions of the breech plug are calculated by empirical formulae based on experience with this system of fermeture both here and abroad. The elevating band is shrunk on, and adds but little, and is not intended to contribute any, to the strength of the gun. The gun is rifled with 24 lands and 24 grooves, the former 0.300 inch and the latter 0.4847 inch wide at the rear end. The grooves are 0.05 inch deep, with the corners formed by arcs of circles of 0.02 inch radius. The sides of the lands are inclined slightly in from the centre, and when produced cross each other and are tangent to a circle at the centre 0.15 inch in diameter. The developed curve of the rifling is a semi-cubical parabola. The twist starts with one turn in 180 calibres, increasing uniformly for 134 inches, where it is one turn in 30 calibres, and from there on it is uniform at one turn in 30 calibres to the muzzle. The reverse edge of the grooves is given a twist slightly less than that of the driving edge, in order to decrease the width of the grooves by 0.05 inch from the breech to the muzzle end of the bore. This is done to allow for the wearing of the band,

ensuring a good hold on it throughout the bore, and preventing the gases from getting by the band and causing erosion.

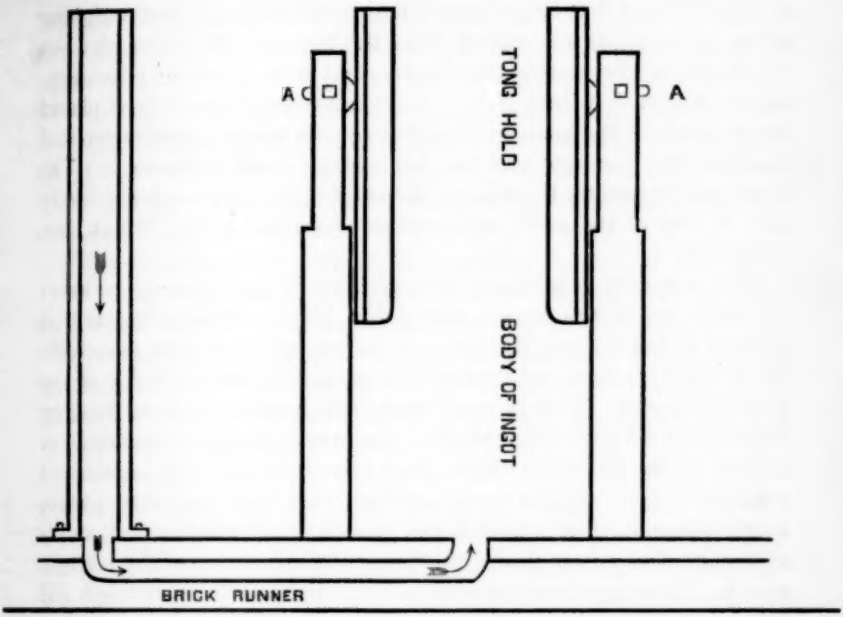
Mark I. was the same as Mark II. in all essential points, and differed from it only in certain details. The grooves in Mark I. were the same width throughout.

No. 1 gun was the only one made on the Mark I. design. All the others were made according to Mark II.

The gun is designed to fire a projectile weighing 100 lbs. with a charge of 50 lbs. of powder, this giving a density of loading of .99 in Mark I., and .98 in Mark II.

The tube is forged from an ingot of cast steel 30 inches square and about 55 inches long, with a tong hold 12 inches in diameter and 3 feet long, and weighing 15,000 pounds. In casting this ingot the charge is melted in the ordinary manner in a Siemens open-hearth furnace of 7 tons capacity. Just before the furnace is tapped the metal is stirred with hickory rods (Siemens' method). When the metal is about ready for casting, the fluid steel is tested several times by dipping out some of the steel with a spoon and pouring it into small moulds. The castings made in this manner are broken and the fractures examined with the eye, to determine the carbon and solidity of the metal. When all is ready the metal is tapped into a ladle and run from that into the mould, which is built of the shape shown in the sketch. In pouring the ingot the metal is run from the runner until it comes up into the bottom of the tong-hold mould. The ladle is then moved over the top of the mould and the rest is poured in at the top of the tong hold directly from the ladle. About five minutes is required to run the metal in from the bottom and five minutes more for pouring in at the top. After casting, several pots of crucible steel are poured into the tong-hold mould to feed the skrinkage, the last pot going in about an hour and a half after casting. During this time charcoal is thrown into the top of the mould to keep the top of the ingot fluid. The pins *A*, *A* are now taken out to free the tong-hold mould and allow the tong hold to shrink with the body of the ingot. The ingot is then allowed to cool in the air of the shop.

For forging, the ingot is placed in the furnace for the first heat, remaining about 24 hours. It is then put under the hammer and hammered gently all over to close the blowholes. It is then returned to the furnace and, in 18 hours more, heated with a blast to a bright forging heat, and reduced under the hammer to an octagon about 17



inches wide on each side, and then allowed to cool on the floor of the shop, when defects on the surface, brought out by hammering, are removed with a chisel. The forging is then reheated and hammered on a V-shaped anvil until it is gradually reduced to the required diameter. To forge the ingot to these dimensions requires about a dozen heats, and about twelve hours under the hammer. At each heat the ingot is hammered all over until it becomes too long for the furnace, when one end is heated and hammered at a time. When the forging is finished, the extra metal at the ends is cut off, and bars cut from this are tested. The tube is then annealed in a special annealing furnace at a heat depending on the physical characteristics exhibited by the last test. As the company has no facilities for rough-boring and turning, the tube is sent to the Washington Navy Yard for this purpose.

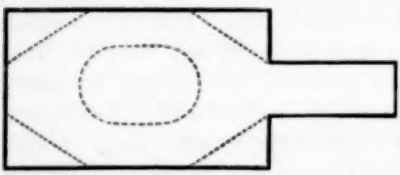
The jacket is made from an ingot similar in all respects to that for the tube, and the process of forging, annealing and testing is very much the same.

The hoops for the first few guns were made in the following manner: The ingot, about 13 inches square, and weighing about 1000 pounds,

was heated and first forged into a rough cylinder. A piece weighing about 400 pounds was cut off from the top, and the remainder was upset into a cheese-shaped cylinder, and a hole about 11 inches in diameter punched through it. After this it was reheated and placed on the horn of the anvil and hammered into shape, a tool interposed between the hammer and the hoop being used to finish it. The hoop was frequently shifted end for end on the horn, and was finally laid on top of the anvil and hammered on the ends. It was then annealed.

The hoops are now forged on a mandrel in the following manner: An ingot 15 inches square and 4 feet long, weighing about 3100 pounds, is heated and the upper third cut off, the lower two-thirds being cut into three or four pieces, according to the width of the required hoops. This bloom is reheated, hammered to an octagon shape on a flat die under the 9-ton hammer, upset and hammered to a disc 10 or 12 inches thick, then turned on the side again and rounded. The ingot is then punched, first with a conical punch, nearly through, then capsized and placed on an annular disc, and a second conical punch driven through. This is followed by a larger punch. The ingot is again capsized and the punch put through the other way. It is then hammered on the sides to smooth it, and then allowed to cool, in order to chip out any imperfections. The hoop is then from 10 to 12 inches thick, with a hole 9 or 10 inches in diameter. It is then hammered on a slightly tapered mandrel, on a V-shaped anvil, and then finally hammered in a die to the proper width. It is then oil-tempered, and test bars are submitted for inspection.

It was at first intended that the trunnion hoops should be of forged steel. With this view, two attempts were made to reduce a cast ingot



under the hammer to a slab like this sketch, and, by punching a hole in the centre, cutting off the corners, and delicate hammering, to bring it to the required shape. The first ingot had to be abandoned; the second was finished to shape, but the metal proved unsatisfactory. It was then decided to cast the trunnion hoops, and all of them were accordingly made in this way.

When the tube is received at the Washington Navy Yard, it is put in the lathe, great care being taken to have it exactly centred. It is then rough-bored to within $\frac{3}{8}$ of an inch of the finished diameter. It

is then rough-turned to within the same margin. It is not rough-turned and bored closer to the finished diameter, on account of the slight warping which takes place in oil-tempering, thus necessitating recentring. The jacket is rough-turned and bored to within ¼ of an inch of the finished diameter in the same manner as the tube, except that a hollow boring-tool is used, which cuts out a solid core from the centre weighing about 900 pounds, which may be used to make a 3-inch B. L. howitzer.

The tube and jacket are then reshipped to the steel works, where they are oil-tempered. For oil-tempering, the tube or jacket is heated in a wood fire and then dipped a number of times in a bath of oil. The heat of tempering and the number of immersions are determined by the previous tests of the metal. This process is one of the most important steps in the manufacture, and on its success depend to a great extent the physical characteristics of the metal.

The metal is now tested by the Bureau, and if the tests are satisfactory the pieces are provisionally accepted and are returned to the shops. [6 of the 6-inch guns have been built at the South Boston Iron Works, 5 at the West Point Foundry, and the rest at the Washington Navy Yard.] No. 1 gun had none of its pieces oil-tempered, and was built up as the pieces came from the works.

The jacket is now put in the lathe and fine-bored as near as possible to the established diameter. It is then star-gauged. As it is much easier to cut to an exact diameter on the outside of an ingot than on the inside, the tube is turned down in wake of the jacket to the measured diameters of the corresponding parts of the jacket (+ the shrinkage). It is also fine-turned in wake of the chase hoops. The measurements on the inside of the jacket vary not more than .002 inch or .003 inch from the required diameters.

The tube and jacket are now removed to the shrinking pit. The tube is placed, muzzle down, in the centre of the pit and firmly supported there. A wooden box is built around the shoulder. The jacket, after being carefully cleaned and wiped out on the inside, is placed, breech end up, in a wrought-iron flask, and a wood fire built up all around it and lighted. This fire is kept burning until the operator, by inserting a gauge in the jacket, finds that it has expanded to the proper interior diameter to allow for the shrinkage and sufficient clearance to slip easily over the tube (about 0.01 inch or 0.02 inch all around). The flask is removed and the jacket lifted by a crane, transported directly over the tube, and lowered into its place. A

stream of cold water is then turned on the muzzle end of the jacket (in the wooden box), to make it cool there first and nip, drawing the rear part close against the rear shoulder.

When the jacket is cool, the gun is lifted from the pit and placed horizontally on skids. The chase hoops, bored out to the established diameter, are successively heated in the same manner as the jacket, and after being carefully wiped out are slipped over the tube and forced into place, while a stream of water is turned on the end of the hoop nearest the trunnions, in order to make it nip there first, and thus make a neat joint with the jacket or the hoop next to it.

When all the chase hoops are shrunk on, the gun is once more put in the lathe and the jacket turned to size, and the chase hoops and chase fine-turned. The *A* hoops are then shrunk on in the same manner as the chase hoops, and the gun is again put in the lathe and fine-turned. The next step is to cut the thread on the gun and to screw on the trunnion hoop. The muzzle and breech faces are then faced off to the proper length. The gun is now fine-bored, and the chamber reamed out. The reamer for this purpose is made the exact shape of that part of the bore, and cuts the two cones and the intervening cylinder all at once. The gun is now ready for rifling.

The rifling bar used is five inches in diameter, with a groove cut in it whose twist is the same as that of the rifling. To cut this groove, the developed curve of the rifling is laid off on a horizontal plate at the side of the lathe. A groove is cut along this curve, in which travels a stud, which moves a ratchet gearing into a wheel on the end of the bar. As the bar travels along the lathe, the stud and ratchet move out in the groove, causing the bar to revolve, and the stationary cutter cuts the required groove. The rifling head carrying the cutters is fitted on the end of the bar.

The rifling is done in a planing machine, as there is no special rifling machine in the shops. The gun is laid on the planer table* *b*, supported in a chock, *c*, and carried in a collar, *d*, by which it may be revolved about its axis and a new surface of the bore presented to the rifling tool when desired. On the muzzle end of the planer is a standard, *e*, which passes freely along the rifling bar *f*, and serves as a support to it. It has a stud projecting down into the groove in the bar. As the gun moves forward, the stud, moving in the groove,

*See Vol. XI., Proceedings of the Naval Institute, No. 33, page 337, for drawing and description.

causes the bar to revolve, and the cutters cut a groove in the gun which is a reproduction of the one on the bar. There are eight cutters on the rifling head, and eight grooves are thus cut at once. The grooves are first roughed out all around, and then finished to the required profile with finishing cutters. On account of the difference in the width of the grooves at the breech and muzzle, a second groove has to be cut in the bar having the diminished twist of the reverse edge of the groove. The rifling is finished with this groove and the finishing cutters.

The elevating band is now shrunk on and the screw box for the breech plug cut and slotted out, and the breech mechanism is then fitted.

The slotted-screw breech-closing arrangement was adopted in the Navy in 187 , and is the system used in these guns. It was originally intended to use the cup gas-check, but early in the construction of Gun No. 1 the De Bange system was adopted. In the early application of this system of obturation,* the pad, filled with asbestos and mutton suet, was enclosed between two sets of rings of peculiar cross-section made of tin, copper or other soft metal, or of an alloy. In practice at the Naval Proving Ground at Annapolis, these rings were found, after firing, to stick to the wall of the chamber, and thus to prevent the ready withdrawal of the breech plug. Experience showed the necessity of a harder material, and in June, 1884, the Bureau of Ordnance ordered a pair of retaining rings made of steel. After ample trial they were found to be entirely free from tendency to stick in their seats, and were then adopted as standard. It has been found in firing that the pad itself often sticks badly, making it extremely difficult to turn the plug to the withdrawing position. To remedy this, an important modification has been made in the mechanism—viz.: the spring has been left out, and a frictionless washer has been introduced. This consists (as will be seen in the drawing) of two grooved cups fitting together, the grooves enclosing a number of spherical steel balls, and thus enabling the two cups to revolve around their axis without grinding together. By this means the breech plug can be turned without turning the mushroom and pad, and the pitch of the interrupted screw in the plug is sufficient to start the pad to the rear and free it from its seat. In practice this is found to work admirably, and the plug can be easily turned and withdrawn without the use of the cam.

* See Vol. XI., No. 33, Proc. Nav. Inst., page 336.

The gun is next sighted. Both centre and side sights are fitted. The appended sketch shows the front and rear side sights.

In February, 1884, the 6-inch gun No. 1 was fired for the first time. The charge was of sphero-hexagonal powder, and beginning with 25 pounds, it was gradually increased up to 45 pounds. The velocities increased from 1252 to 1910 f. s., and the pressure from 6.2 to 16.8 tons per square inch. Later, 45 pounds of another brand of this powder gave 1927 f. s. velocity with 17.3 tons pressure, which is remarkably good for black powder, and illustrates the great progress made in the manufacture of powder in this country. In May, with still another brand of this powder, the following results were obtained:

Powder.	Charge (lbs.).	Pressure (tons).	Muzzle Velocity (f. s.).	Projectile.
Dupont's Sphero-Hex. (56)	40	12.8	1825	100 pounds, with copper band 6.12″ in diameter.
	43	14.8	1892	
	45	15.4	1951	
	46	16.2	1970	
	47	15.9	1978	
And later:	44	16.1	1922	100 pounds, with copper band 6.12″ in diameter.
	45	17.2	1948	
	46	16.4	1987	
	45	21.9	1948	
	48	20.9	2005	

This powder was evidently too violent, and gave pressure that no gun could be expected to stand in service. Meanwhile, however, Cocoa powder had been developed in Germany, and the Bureau had ordered an experimental lot from each of the firms—the Westphalian and the Rothweil. This arrived in June, and was fired from the 6-inch gun with the following results:

Powder.	Charge.	Pressure.	Muzzle Velocity.	Projectile.
Cocoa "A," Westphalian.	25	5.2	1277	100 pounds, with copper band 6.12″ in diameter.
	30	6.9	1406	
	35	8.7	1555	
	38	9.4	1624	
	41	10.4	1705	
	43	11.1	1773	
	45	11.7	1808	
	47	12.2	1836	
	49	12.8	1890	

Powder.	Charge.	Pressure.	Muzzle velocity.	Projectile.
Cocoa "B," Rothweil.	35	10.3	1666	100 pounds, with copper band 6.12″ in diameter.
	40	10.5	1717	
	45	12.7	1841	
	47	13.9	1925	

In October a number of rounds were fired with 50 pounds of C_{88}, the powder adopted for this gun, for the purpose of determining the initial velocity in connection with the preparation of a range table. This resulted in 1915 f. s. being taken as the average initial velocity for this charge.

A number of rounds were then fired with this charge and the service shell at different elevations, with the following results:

Elevation.	Mean Range (yards).
4°	3714
5°	4375
6°	4990
7°	5550
8°	6057
10°	7008

In February, 1885, several shots were fired with increased charges of C_{88}, with the following results:

Charge.	Pressure.	Muzzle Velocity.
45	9.5	1630
50	11.3	1835
52	11.9	1860
54	12.6	1906
56	12.8	1960
58	14.1	2000

As a result of these experiments with Cocoa powder, the powder for the U. S. S. Atlanta was ordered from Germany.

During the past year a series of experimental powders of Messrs. Dupont have been tried, with gradually improving results, until at last a Cocoa powder was furnished by them which in November last gave the following results:

Charge.	Pressure.	Muzzle Velocity.	Projectile. (Weight in lbs.)
50	12.2	1881	100
54	13.2	1928	100
56	13.9	1967	100
58	14.2	2011	100
58	15	2019	101.5

The best result was obtained in July, when 50 lbs. of Dupont's brown Cocoa powder with a 100-lbs. shell gave a velocity of 2011 f.s. with a pressure of 14.3 tons.

The 6-inch gun No. 1 has been fired in all 271 times, with charges varying from 25 to 58 pounds of powder. The pressures have risen to 17 and 18 tons, and on two occasions even to 20.9 and 21.9 tons, per square inch. Of course, as a rule the pressures have not been higher than 15 tons, but it is clear that the gun has at times been subjected to very severe strains, much greater than it could ever have to bear in practice with a well-known service powder. All this has naturally resulted in a quite considerable scoring of the bore. The diameter of the chamber has been permanently increased—to the greatest extent at the forward end, where the increase is 0.014 inch. The diameter of the bore across the lands has been increased throughout, the increase varying from 0.042 inch at the beginning of the rifling to 0.003 inch at the muzzle. The diameter across the grooves at the rear seat of the projectile has been increased to 6.120 inches. The corners of the grooves at the beginning of the rifling have been considerably cut into. In addition, there are shallow scores all along the walls of the chamber, and in the bore for a distance of several feet.

To remove as much as possible the bad effects of this scoring at its worst point, the chamber reamer has been set to work again and advanced an inch and three-quarters farther into the bore. A slight increase in the charge of powder will counteract the effect of shortening the travel of the shot, at the same time giving about the same velocity and pressure.

This gun will be put on board the Dolphin, and when, after repeated firing, the scoring has greatly increased, it may be relined.

The only projectile that has so far been finally adopted for the 6-inch gun is the cast-iron common shell, of which a sketch is here given. It is 3.48 calibre long, and the mean thickness of the walls is 0.47 calibre. It weighs, loaded with a bursting charge of 7 lbs., 100 lbs. These shell have been made in large quantities at the Washington Navy Yard. The expansion band is of the shape shown in the sketch, and has been made of copper tubing and of cast brass. It is forced on by a hydraulic press, and then turned down to size. 6.12 inches is the diameter, and this seems to allow sufficient compression to make the band take the rifling firmly. The following table will show the results of some experiments made with bands of different diameters:

Charge.	Projectile.	Band Material.	Diameter of Band.	Pressure.	Muzzle Velocity.
50	100	Copper tubing.	6.12	11.8	1836
"	"	"	6.14	12.2	1865
"	"	"	6.16	12.2	1865
"	"	"	6.18	13.0	1880
"	"	"	6.20	12.6	1880
"	"	"	6.20	12.5	1880
"	"	"	6.22	12.7	1889
"	"	"	6.24	14.3	1924
"	"	Cast brass.	6.15	12.1	1844
"	"	"	6.12	11.8	1839
"	"	"	6.12	11.8	1826
"	"	"	6.18	12.7	1880

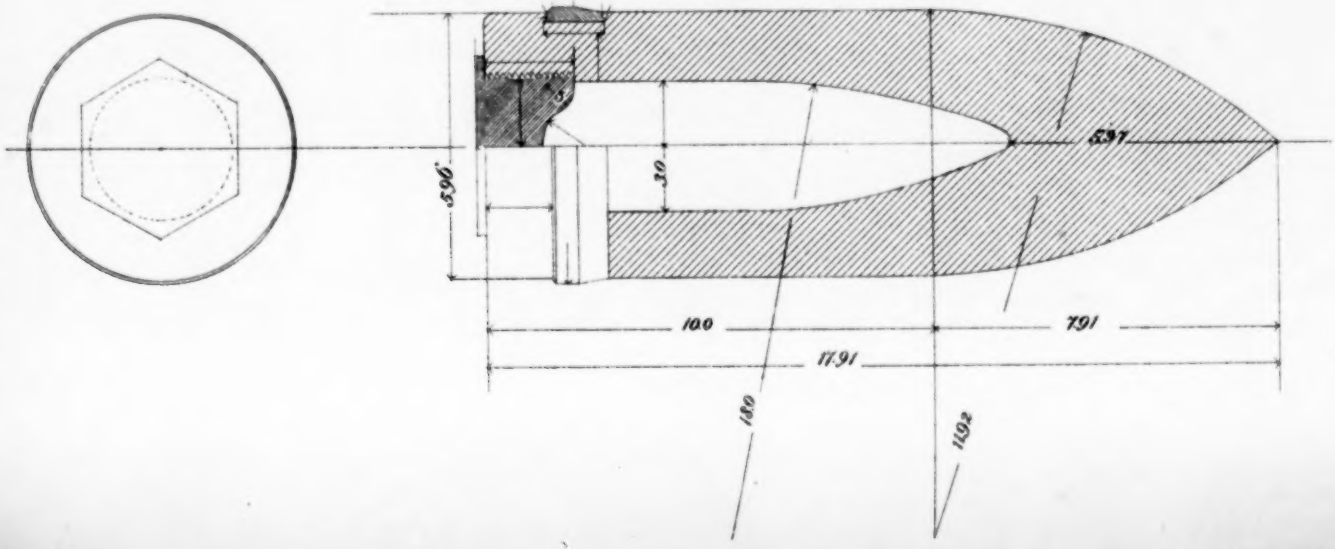
Quite a number of experimental steel shell have been made and tried. The most successful was a chrome-steel armor-piercing shell, the ingot for which was furnished by the Chrome Steel Works of Brooklyn. This shell was manufactured, tempered and banded at the Naval Proving Ground, and weighed 101.5 lbs. It was fired with a charge of 58 lbs. of Dupont's Cocoa powder against an 8-inch Brown compound plate, backed with 20 inches of oak and an iron skin-plate. The muzzle velocity was 2025 f. s., but, unfortunately, the elevating gear slipped, and the shell went over the target into the butt. It was recovered and fired again with the same band, the muzzle velocity falling to 1941 f. s. The shell struck the plate at the point aimed at and remained in the target (the butt protruding seven inches) unbroken, somewhat upset, and badly cracked. The effect on the plate was very marked. A single rent extended through the entire plate to the upper edge. There is a decided bulge, about one inch in depth and six inches in diameter, in the skin-plate, indicating that a segment of the plate has probably been driven some distance into the backing.

These two shots, with the one mentioned before (2011 f. s. with 50 lbs. of powder), represent the best results that have been obtained with the 6-inch gun as regards both powder and projectile, and they are unequalled by any results hitherto attained anywhere.

SPECIAL NOTICE.—Since this article was written, still further progress has been made in the manufacture of Cocoa powder by the Messrs. Dupont, as will be seen by the following remarkable results, obtained at Annapolis with a 6-inch B. L. R. Mark II, and a 100-lb. projectile:

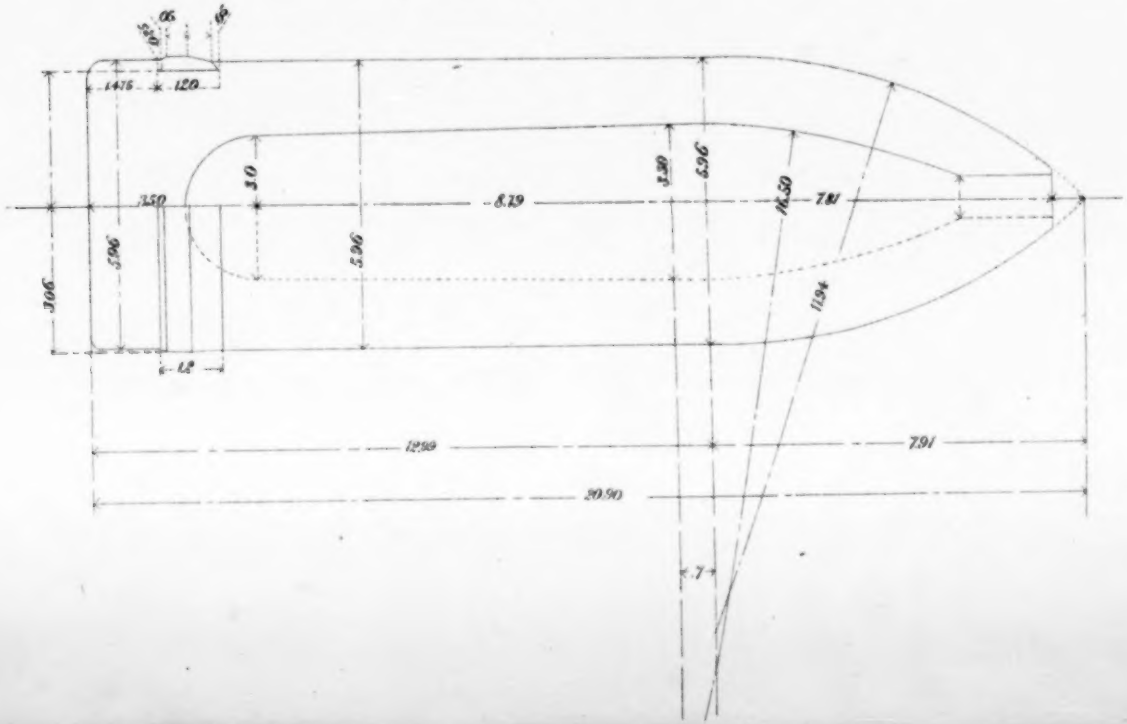
Date.	Charge (lbs.).	Initial velocity.	Pressure (tons).
Feb'y 27, 1886.	50	2029	13.3
March 11, 1886.	52	2052	13.6
	53	2080	15.3
	54	2105	15.6

6in Battering Shell.
(Steel)



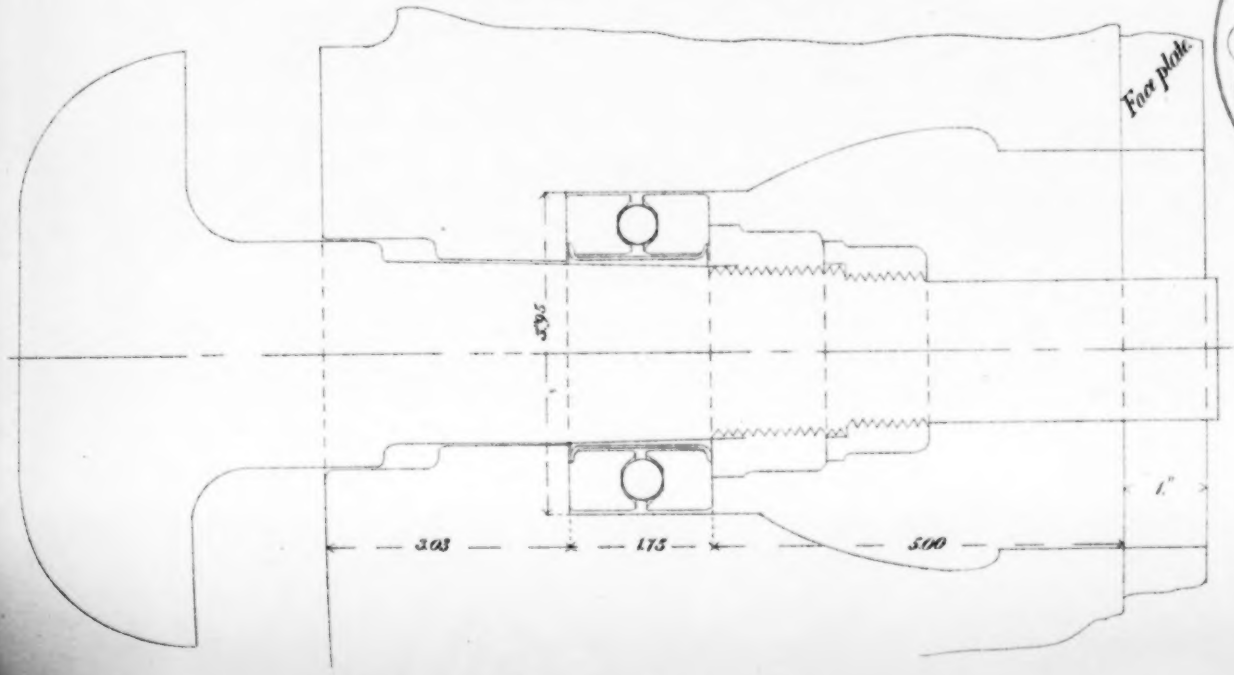
No 2.

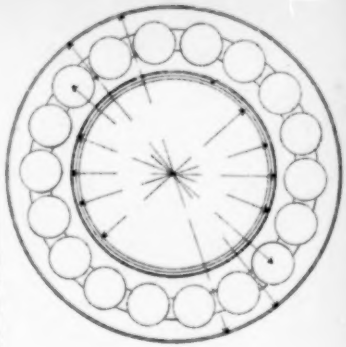
6 in Common Shell
(Cast Iron.)

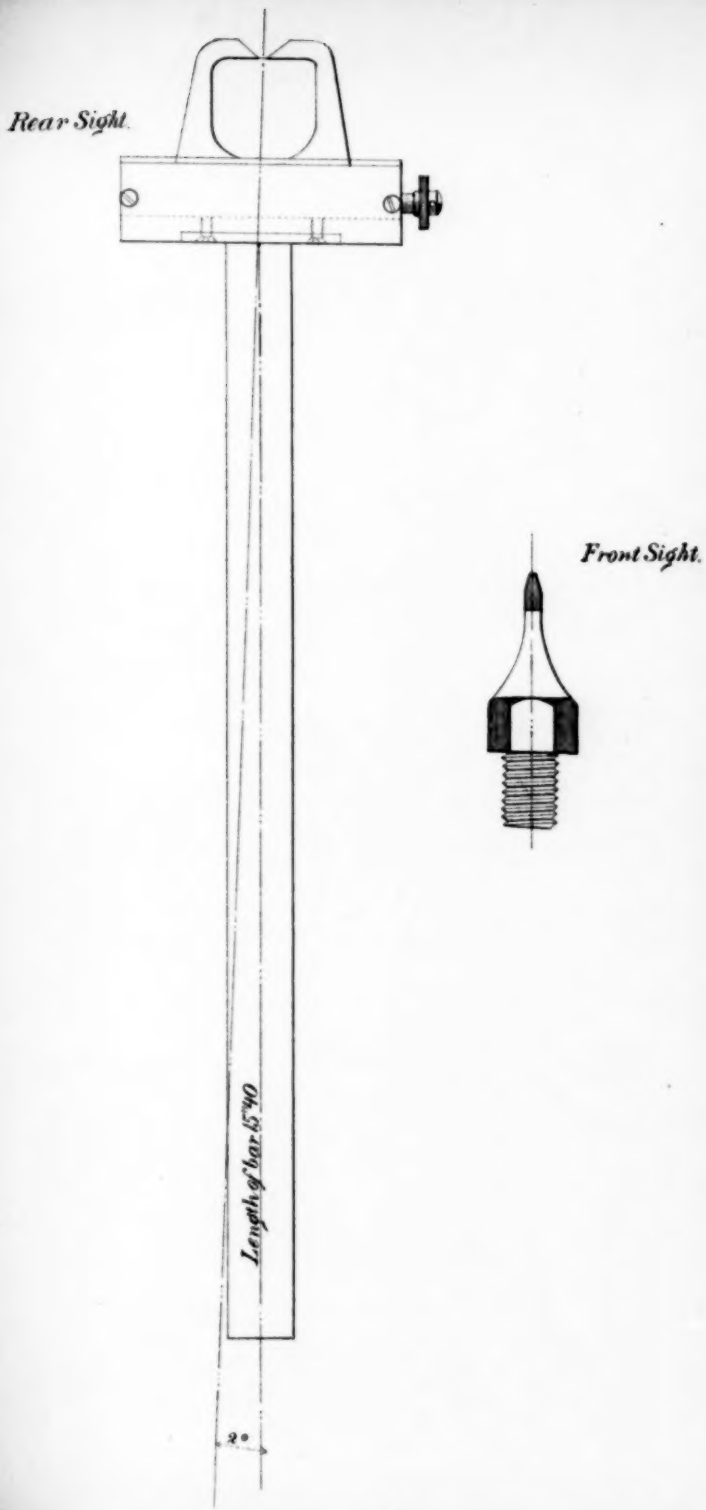


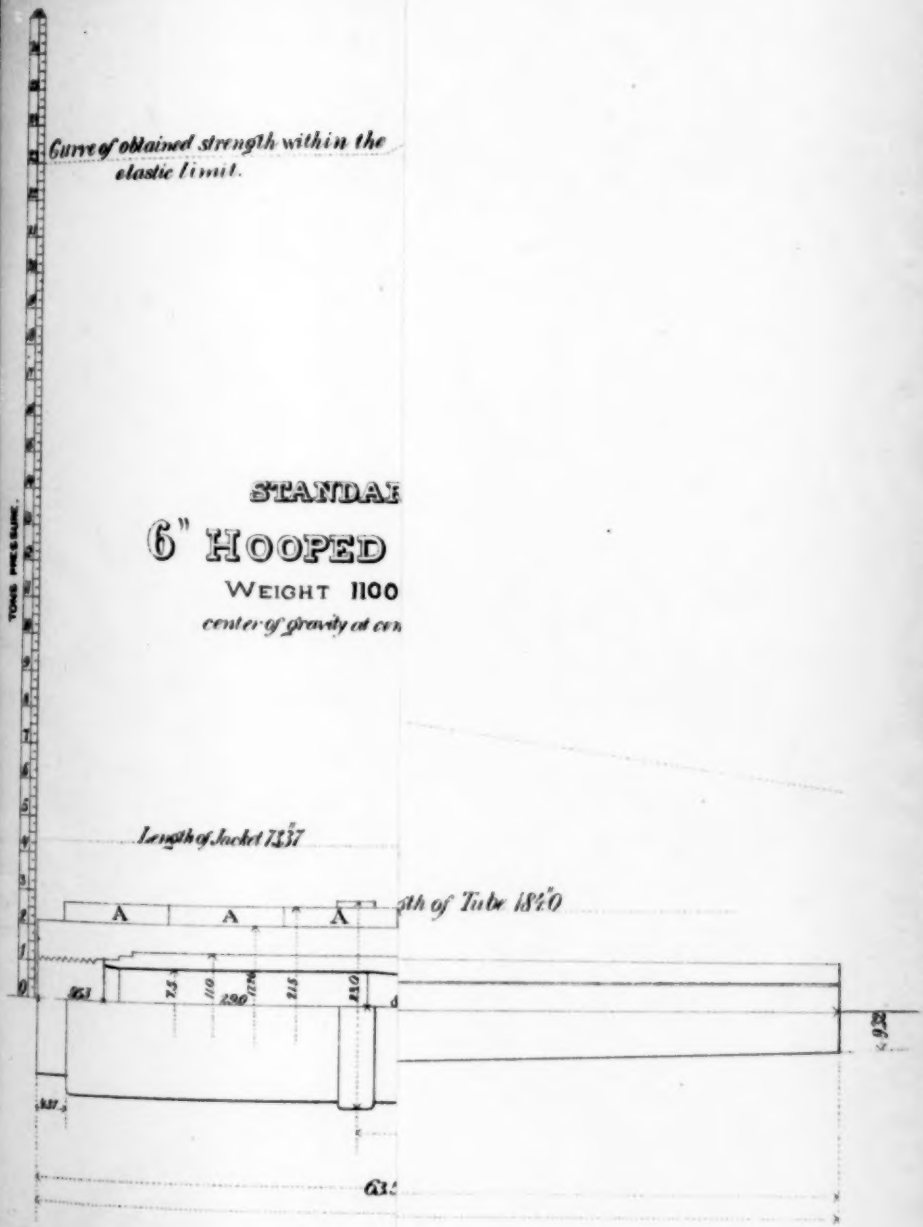
6" B.L.R.

Modification of Recess for Spring of Mushroom Stem to receive Frictionless Washer.






Rear Sight.
Front Sight.
Length of bar 15"40
2°

TONS PRESSURE.

TONS PRESSURE.
Curve of obtained strength within the elastic limit.
STANDAR
6" HOOPED
WEIGHT 1100
center of gravity at cen
Length of Jacket 7.37
th of Tube 18.0
A
A
A
.953
.75
.110
2.90
.128
.215
.230
.937
.932

Curve of obtained strength within the elastic limit.

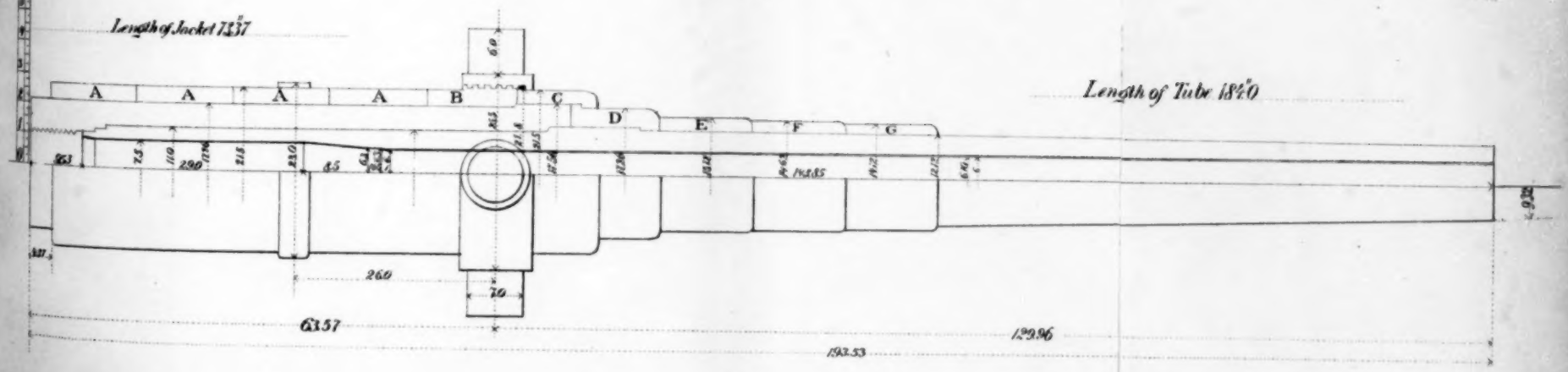
TONS PRESSURE.

STANDARD
6" HOOPED BLR.

WEIGHT 11000 LBS.

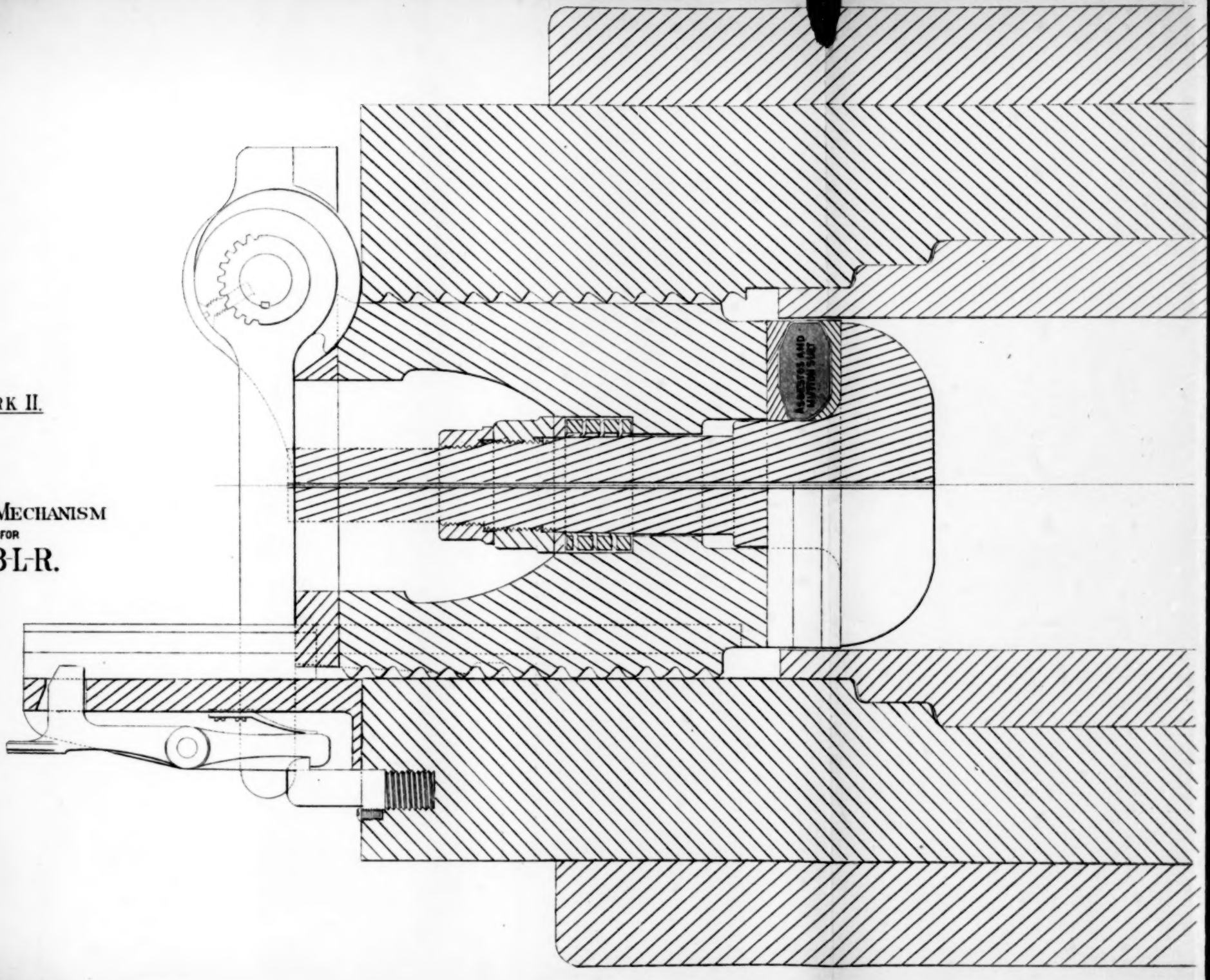
center of gravity at center of trunnions.

MARK II



MARK II.

BREECH MECHANISM FOR 6IN B.L.R.



U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE PRESENT COURSE IN ORDNANCE AND GUNNERY AT THE NAVAL ACADEMY.

By Lieutenant R. R. Ingersoll, U. S. N.

The course in the Department of Ordnance and Gunnery at the Naval Academy having been materially changed within the past three years, chiefly in the manner of imparting instruction and by the introduction of new work, and much interest, coupled with some curiosity, having been shown by a large number of officers of the service as to what is now being done, the writer, with the consent of the Superintendent, will attempt to give a description of the scope of the present course, for the information of the service at large. It will be understood, however, that the present article is not intended as a comparison of the present system with any other which formerly existed, or to invite a discussion of the subject, but is intended solely to gratify the interest which, as before stated, has been excited. It is hoped, also, when it is seen by the officers of the service how much is being accomplished by the young graduates of the Academy, that the older graduates may be stimulated to perfect themselves in this most important study, the value of which cannot be overestimated.

The instruction being practical as well as theoretical — the term theoretical here is used to include all that is taught in the section-room, although it by no means consists of pure theory alone—and since the practical course begins with the lower classes, the section-room instruction being confined to the 1st Class, the former will first be described.

Practical Instruction.

The following ordnance is available at the Academy for practical instruction, and the whole of it is used at some period or another during the four years' course:

Smooth-Bore Ordnance.

A battery of VIII-inch Dahlgren guns, in broadside, U. S. S. Santee.
6 32-pdr. Dahlgren guns, in broadside, U. S. S. Wyoming.
2 XV-inch guns, U. S. S. Passaic, monitor carriages.
1 XIII-inch mortar.

Rifled Ordnance.

1 8-inch M. L. R., Ericsson carriage, U. S. S. Wyoming.
1 80-pdr. B. L. R., central recoil check, " "
1 60-pdr. M. L. R., directing bar, " "
1 60-pdr. M. L. R., " " U. S. S. Standish.
1 60-pdr. B. L. R., " " " "
1 3-inch steel B. L. R., boat and field carriages.
1 37-mm. Hotchkiss revolver cannon.
2 long Gatlings, cal. 45.
1 short Gatling, cal. 45.

In addition to the above may be mentioned 12 3-inch B. L. R. bronze guns, field carriages, which are used for light artillery exercise, and a full outfit of breech-loading small-arms. Detailed instruction is given by divisions, as a rule, and a further subdivision of the work is made, when possible or advisable, by giving separate and progressive instruction to each class of a division; the exceptions being general-quarters and target practice on board the Wyoming, and battalion exercises in which all the cadets engage, and which, all told, consume but 35 of the whole number of instructions during the academic year. The following is the whole number of instructions which each cadet receives in all that pertains to ordnance and gunnery while at the Academy: 1st Class, 100; 2d Class, 123 (including summer months); 3d Class, 90; 4th Class, 113 (including September). In addition may be mentioned all that is taught in this connection while on the practice cruise.

The programme of Practical Instruction and Summary, as published in the Annual Register of the Academy, and which was introduced and put in force by the present Superintendent, shows at a glance the work done by each class throughout the entire course, and the number of instructions in each branch which each cadet receives. This plan works smoothly and admirably, the distinguishing feature, as relates to gunnery, being, as before stated, *progressive* instruction; the simpler and less important duties being mastered in detail by the lower classes, and the requirements increasing in importance to

the end of the 1st Class year. At the same time, enough general exercises are given involving all that has been taught from the beginning, so that the whole is kept fresh in the mind.

The following table gives the whole number of instructions which a cadet receives as infantry or light artillery during the four years:

Kind of Instruction.	1st Class Year.	2d Class Year.	3d Class Year.	4th Class Year.	Total, 4 Years.
School of the Soldier.....				34	34
School of the Company.....	5	6	6	11	28
Skirmish Drill.....	5	5	5	5	20
School of the Battalion, Infantry.	12	13	13	13	51
School of the Section.....				10	10
School of the Battery.....	5	6	6	6	23
School of the Battalion, Artillery.	10	10	10	10	40
Total each Year.....	37	40	40	89	

The 4th Class is instructed during the month of September in the School of the Soldier and School of the Section, so that at the beginning of the academic year the members of the class are ready to join their companies or batteries, and thenceforward take part in the exercises in which the battery, company, or battalion of infantry or artillery engage.

All cadets but the 4th Class have thorough instruction in the use of the small sword and broadsword.

The instruction in the handling and use of great guns begins with the 4th Class; but the detailed instruction for this class is confined to the use of broadside smooth-bore guns. This work is extended to and completed in the 3d Class year, the broadside guns on the Santee being used for this purpose. One division of 3d and 4th Classmen receives instruction at the same time, and as the number of cadets thus employed rarely exceeds two guns' crews, close attention to details is possible on the part of both instructor and cadets. In all, twenty-four instructions are given to each cadet, and time is allowed for the proper performance of all the duties. The general exercises on board the Wyoming, which will be mentioned in their turn, also include the handling and firing of broadside smooth-bore guns; the gun captains and important members being 1st and 2d Classmen.

Next, the 3d Class go to pivot-guns, one division at a time, at

which the instruction is continued in detail as before, using the different types of gun carriages; and each cadet receives eleven instructions at these guns. This work is continued in the 2d Class year by divisions, each cadet receiving six instructions, and with this class ends the detailed exercise with heavy guns, but by no means concludes the practical instruction in their use, as will be seen later on.

The most useful, however, of all the practical instruction in gunnery is the target practice, in which the detailed instruction is given by divisions, each class, as a rule, having different work. This begins with the cadets of the 3d Class, the members of which are first instructed with rifles in the proper method of pointing, a fixed rest being used. The instructor explains the errors which may result from an improper position of the eye with respect to the sights, from an inclination of the rear sight from the vertical when elevation is used, and from other causes, after which gallery practice with reduced charges and targets is given. This practice is extended by divisions to the use of pistols and revolvers, and later in the year a third practice is given at the rifle range with rifles, with the result of constant improvement in the shooting. Each cadet of the 3d Class gets, in all, three weeks' instruction in the exercise periods, firing every day, and in the last practice firing fifty or more rounds.

During the summer months, after passing into the 2d Class, much time is devoted to practical gunnery. Divisions are formed of the class, and each division is separately instructed in the use of howitzers afloat and target practice with howitzers, the steel 3-inch B. L. R. being used, and which includes ten instructions for each cadet; after which machine guns are used, with five instructions for each. Then exercise is given in the handling and firing of the XIII-inch mortar; five instructions for each cadet; and finally each division in turn has target practice on board the Standish. This steamer is fitted with a 60-pdr. B. L. R. pivot gun forward, and a 60-pdr. M. L. R. pivot aft, both mounted on directing bar carriages, and each commanding a large arc of train on each side.

The work is done as follows: The steamer leaves her dock early in the afternoon, steams out into the bay, and a regulation target is anchored. The steamer takes up a position at not over 1200 yards from the target. As this is the beginning of firing heavy guns afloat, the steamer is kept as stationary as possible, and the distance of the target is tested from time to time by a Gatling gun. The range is given to the cadets, who begin firing, ample time being given to

aim correctly, and the errors in range or direction are noted and corrected by the instructor as the practice proceeds. The loading is carefully watched to prevent accidents, and the proper use of the recoil checks is explained and insisted upon. The fall of the shot is recorded by two observers, one on the steamer and one at right angles to the line of fire, and 1200 yards from the target. Each cadet fires at least five shots, on the same day, if possible, in order to correct his errors in successive shots, and he sees about sixty shots fired. The practice is much better than might be expected from a first experience, and the preceding exercises in pointing and firing small-arms, howitzers and machine guns, are undoubtedly of great benefit.

During the academic year the 2d Class again receives instruction in machine-gun practice afloat, a steam launch being used fitted with regulation mounts, each cadet firing 500 rounds or more with the Gatling gun and several shots with the Hotchkiss gun. A fixed target is used, but the practice takes place at full speed, approaching or moving past the target.

The cadet, having become a member of the 1st Class, again has practice at the beginning of the first term with the guns of the Standish, each division taking a week in turn. The plan followed out is for the steamer to leave her dock at 3 p. m., returning about 6 p. m.; and the firing is conducted in most respects like that previously described, but quick shooting, combined with accuracy, is attempted. Each cadet fires at least five shots, and sees about sixty fired.

Finally, in the second term, this practice is repeated, a division of the 2d Class assisting to handle the guns and witnessing the firing. In this last instruction, however, the steamer moves at full speed between two fixed points which are each 1200 yards from the target, and which form with the latter a right triangle. An observer is stationed at each point to note the fall of the shot. The cadets are each required to fire two rounds in succession within three minutes, the beginning and end of that period being marked by blasts of the steam whistle, the guns not being loaded before the first blast is heard. About fifty rounds in all are fired by each division.

On six Saturdays in October and November the whole 1st Class goes on board the monitor Passaic. Steam being ready, the moorings are at once slipped, the monitor steams out into the bay, and exercise and target practice with the XV-inch guns follow. Shell, shrapnel, and canister are used, and from four to six rounds are usually fired

on each occasion. The class is divided into four divisions, one of which in turn goes to the engine and fire-rooms, and the others are distributed to the gun and powder divisions.

In addition to the detailed instruction, all the cadets, stationed as a ship's company, man the Wyoming during the exercise periods of a week, for the purpose of instruction in the duties of "clearing ship for action" and "general quarters"; the time being taken up with preparing the steamer for battle and exercise at the guns, one division of 1st and 2d Classmen going in turn to engine and fire-rooms. On four Saturdays the ship's company goes on board at 8 a. m., and, steam being ready, the moorings are at once slipped and the steamer proceeds out into the bay, clearing ship for action on the way out. Once outside the harbor, target firing begins with the whole battery, the Wyoming steaming around the target. Frequently over thirty rounds are fired before returning to the harbor, the steamer being moored about 1 p. m. While under way on board the Wyoming, Passaic, and Standish, the cadets run the engines, steer the ship, and heave the lead, performing the work of enlisted men.

This concludes the practical instruction in handling and firing guns under service conditions, and at least this much may be said of it—that a cadet who graduates from the Academy after having gone through the whole course, has had instruction with, and has fired, or has seen fired, every class of gun at present in use in the Naval service. In addition to all the foregoing, however, there are certain periods devoted to what is termed practical ordnance. The distinction between ordnance and gunnery being difficult to define, it will suffice to say that many of the things taught in these periods are absolute essentials to the complete education of a gunnery officer, and that the remainder are deemed of great importance, should an officer be called upon to perform ordnance duty. The exercise periods for two weeks are devoted by each cadet of the 1st Class, and for one week by each cadet of the 2d Class, to this work.

The instruction for the 2d Class includes the following:

To dismount and assemble the Gatling and Hotchkiss guns, and to learn the use of each part; to know what to do in case of accidents in firing, and how to clean the pieces; to dismount and assemble small-arms; the nomenclature of service guns and carriages; the construction of ships' magazines; the stowage of powder; to know the use of the different powder charges, projectiles and service fuses. This work for the 2d Class precedes the practice firing with

machine guns. It is so arranged that only two or three cadets are engaged on the same work each day, the subjects being taken in turn; and this applies to the 1st Class also.

With the 1st Class, two or more days are devoted to firing a gun for range, the 3-inch B. L. R. being used for this purpose, and the data thus obtained by all four divisions are used later in the section room, when the method of constructing range tables is the subject for instruction. The gun is also fired for "jump." Next, the Rodman machine is used to find the elastic limit, tensile strength, and ductility of gun metals. Steel and wrought-iron specimens are used principally, and blank forms are filled out for each specimen tested, several specimens being used by each division. Next, the machine is used in connection with the Woodbridge spiral pressure-gauge to construct a pressure curve for use later in the year in determining the pressures in guns. The work also includes the following: taking apart and assembling a full-size model of the 5-inch steel B. L. R.; an examination of the breech mechanisms and various gas checks, including models of those for the new steel guns; star-gauging the 3-inch B. L. R. and taking impressions of the bore; examination of the various powders, including German Cocoa or C_{82} powder, Dupont's brown prismatic and sphero-hexagonal powders; instruction in the contents of the gun-cotton torpedo supply box and the use of the torpedo outfit, and using the inspecting instruments on service projectiles, including those for the steel B. L. R.'s. It should here be added that each cadet of the 1st Class, later in the year, is given five instructions in firing practice torpedoes from a steam launch fitted with the latest apparatus, floating targets being used and attacked under full headway.

Practical instruction also includes the experimental determination of velocities and pressures, but the time is taken from the recitation periods. A firing butt has been constructed in rear of the armory, screens, wires and batteries provided, and a small brick structure has been built to cover the Schultz chronoscope. Various other experiments, involving the measurement of small intervals of time and applicable to gunnery, are sometimes made.

Brief instruction is also given in practical photography as applied to ordnance purposes, dry plates being used. The time being limited, the work is confined to the development of negatives, with some printing, if possible.

The Bureau of Ordnance, Navy Department, has furnished models,

projectiles, material for experiments, drawings and new matter, from time to time, so that the cadets may at least see the latest improvements.

Theoretical or Section-Room Instruction.

Such subjects as it is believed are mastered in the practical work are not dwelt upon, as a rule, in the section-room, and if introduced there, the object is to freshen the memory or to emphasize important features. It is thought that the scope of the section-room instruction will best be understood by a brief description of the subjects covered by the text books. These are:

The *Ordnance Instructions; Text-Book of Ordnance and Gunnery, Naval Academy Publication; Hand-Book of the Hotchkiss Rapid-Firing Gun, Very; Exterior Ballistics, Naval Academy Publication; Elastic Strength of Guns, Naval Academy Publication; Work of Gunpowder in Guns, Sarrau; Probability of Hitting an Object of Any Form, Bréger; Examples in Interior Ballistics, Lt. Meigs, U. S. N.; Ordnance Notes, Printed Notes, and Extracts from Official Reports.*

Some of the above are small pamphlets.

The general rule is to combine descriptive matter with the mathematical work concerning the construction and use of ordnance or ordnance material, when possible, and usually the former precedes the latter.

The *Ordnance Instructions* and *Text-Book of Ordnance and Gunnery* are not completed then at any one time, but parts are selected as may apply to the subject in hand.

Taking the text-books in turn:

The *Ordnance Instructions*, as the official source of information, are used so far as possible for the description, rules, exercises, etc., as applied to the service of guns and the care of ordnance material, the parts concerning rifled guns being considered of most importance.

The *Text-Book of Ordnance and Gunnery*, which is not a complete treatise in itself on these subjects, is intended to supplement the *Ordnance Instructions* with descriptive matter, and to supply in convenient form many things which would otherwise be taught from MS or from notes. In brief, the book contains a description of the properties of gun metals; a description of modern guns and their manufacture, including the new steel guns; the principles of the Vavasseur gun carriage; a description of the machine guns and their

uses; a description of explosives and their manufacture. It also describes the kinds of armor in use, and gives formulas for penetration; contains chapters on the principles and practice of naval gunnery and the rotation of rifled projectiles; touches briefly on torpedoes and field fortifications; and a chapter is added defining the duties of junior officers of divisions. In connection with the subject of machine guns, the *Hand-Book of the Hotchkiss Rapid-Firing Gun* is used.

Exterior Ballistics.—With this book the cadets are taught the theory of the sight-bar, which involves the computing of the permanent angle at which the rear sight-bar is set to allow for drift due to rifling; the marking of sight-bars for various ranges, and the effect on deviation from the line of fire of the position of the rear sight-notch when it is moved laterally. The motion of projectiles in a vacuum is then taken up, and in this connection is shown the practicability, within certain limits, of the use of sight-bars which are marked for ranges on a horizontal plane through the gun, when firing at objects above or below that plane, as is almost always the case in practice. Next in order is the study of the resistance of the air to the motion of projectiles, and then follows the mathematical work necessary to compute trajectories of projectiles in air. Next is shown the effect of the wind, motion of gun and target on the flight of projectiles, and the method of correcting the fire of guns for such errors is taught. Then follow the preparation and use of range tables, in which the data are those found by the cadets themselves with the 3-inch B. L. R. In all of the foregoing, practical examples are introduced, and some recitation periods are devoted to practical work alone.

Elastic Strength of Guns.—The theory of the computation of the strength of homogeneous and built-up guns is taught with this text-book, as well as the shrinkages in the case of built-up guns, and the compression of the bore when the gun is in a state of rest. Examples of guns in use or designed for our service are used in the application of the theory to practice. While on this subject, the cadets are required to make a scale drawing of one of the new steel guns, and to compute and erect over it the line of elastic strength for the whole length of the gun. This drawing comes in play later.

Work of Gunpowder in Guns. Examples in Interior Ballistics.—These are used to teach the method of the computation of the force of explosives developed when fired in their own volume or in a closed receptacle, in order to apply it to determining the force of

bursting charges in shells or torpedoes. The deduction of the equation of the motion of a projectile in the bore of a gun when powder is so fired, and also when powder burns progressively, is also taught, and the theory applied to guns in our service. Then follows the computation of muzzle velocities and pressures when the quantities known are: the density of loading, weights of charge and projectile, calibre, and the travel of the projectile in the bore. The effect of small variations of the elements of loading, and the influence of the shape, size and density of powder grains on velocities and pressures, are also taught. The *Examples in Exterior Ballistics* illustrate each of the foregoing subjects. Several days are devoted to practical work alone, in which, near the end of the course, the cadets are required to compute the elements of, and to erect a pressure curve over the bore of a gun, the scale drawing previously mentioned being used for this purpose. Valuable and instructive data are frequently furnished by the experiments at the Naval Ordnance Proving Ground for use while on this subject.

The Probability of Hitting an Object of Any Form.—The object of this study is primarily to teach the cadets the effect produced in gunnery practice by errors of whatever kind, as shown by the probability of hitting targets of various shapes and sizes, the errors being taken from practice firing when available, with the idea that, understanding the effect, the intelligent officer will use every effort to eliminate the errors whenever possible. That this object is realized, is established beyond a doubt. The application of the theory is extended to fire against ships; to taking up distance from targets of known size and form, and to the determination of the supply of ammunition necessary to accomplish a certain number of hits. This last is of growing importance, when the question of the cost and limited supply of ammunition for modern guns is considered. Practical examples are constantly introduced, and more attention is paid to the application of the various formulas than to their deduction.

In addition to the text-books, Ordnance Notes, printed or in manuscript, are used when engaged on the subjects involved, among which may be mentioned the "Recoil of Gun Carriages," "Gun Designing," by Colonel Maitland, R. A., "The Heavy Guns of 1884," also by Colonel Maitland. Extracts from the Official Reports of the Bureau of Ordnance, Navy Department, are also used when applicable, and every effort is made to keep the instruction up to the progress which is being accomplished in ordnance and naval gunnery.

Each cadet is required to keep a note-book containing all the examination papers (examinations take place monthly), practical examples, notes on practical ordnance work, and such other matter as may be given him for instruction or reference.

In conclusion, it should be said that the cadets take hold of the work with great interest, and, with their mathematical knowledge fresh in their minds, find no difficulty in getting an excellent idea of what, at first sight, seem to be complicated subjects. Undoubtedly they can master them in a much less time now than they could at a later period in life, when, in many cases, they would not be so ready with their mathematical knowledge; and, further, it may be said that the studies involving ordnance matters pure and simple do not interfere with the acquisition of the practical knowledge of the duties of a gunnery officer, which is mainly taught, not in the section room, but by the actual use of the guns. Appended are samples of examination and practical example papers.

APPENDIX I.

Department of Ordnance and Gunnery.

Practical Example, February 11, 1886.

The 8-inch M. L. R. is fired with a 180-pound projectile, at an angle of departure of 10° and a muzzle velocity of 1450 f. s. Find the range on the horizontal plane through the gun. The gun being mounted 20 feet above the water, it is required to mark the side sight-bar for use in firing at an object in the water at a horizontal distance equal to the above range. The jump angle is $+25'$, the permanent angle for deflection is $1° 50'$, the distance between sights is 45 inches, and the rear sight is at right angles to the axis of the bore.

APPENDIX II.

Department of Ordnance and Gunnery.

Semi-Annual Examination, January 26, 1886.

1. Give the Manual in full detail at the orders, "Serve vent and sponge," and "Load" with a 60-pdr. B. L. R. State what is done if the breech is difficult to open, if a miss-fire occurs, if the breech will not lock. What cleaning of breech mechanism is necessary after each round?

2. Name the kinds of powder in use in our Naval Service. What is the proportion of ingredients? How is powder supplied to the gun from a ship's magazine? What general rule governs the number of chains of scuttles? How many light boxes are necessary for each magazine? What is the test for dampness in magazines?

3. What kinds of shell are used with rifled guns in our service? Which are fused, and with what kind of fuse? Describe the fuse used with the 3-inch B. L. R. shell. The length of a B. L. R. battering shell is 17.41 inches, the length of the ogival head is 7.41 inches, and the diameter of the cylindrical part is 5.96 inches: what is the radius of the ogival?

4. In gunnery practice, define "mean lateral deviation," "mean lateral error," "mean absolute error," "mean error in range," "jump," "dangerous space," "clearance angle," and "radius." Make a sketch showing what is meant by the terms, "line of sight," "line of departure," "angles of elevation, projection, sight, departure, and jump."

5. A 3-inch B. L. R. gun is sighted by means of a line of sight in the axis of the bore at a point on a vertical screen distant 50 feet horizontally from the muzzle of the gun. The gun being loaded and fired, it is found that the point of the projectile hit the point aimed at IV = 1000 f. s.; is there any jump? If so, how much? The radius of a gun is 50 inches, and a projectile which leaves the gun at an angle of departure of 5°, the angle of sight being + 15′, and the jump 1°, falls at a distance of 1500 yards on the plane through the point of fall and the gun, and the deviation due to rifling is 10 yards to the right. What inclination from the vertical should be given to the sight-bar, to correct the drift? What is the distance set off on the sight-bar for the 1500-yard mark, when so inclined?

6. Describe the means used in checking the recoil of gun carriages when fitted on the Vavasseur principle. How, in the gravity return carriage for 6-inch B. L. R., is the recoil checked? How is the gun returned to battery? How is the gun held in battery in a sea-way?

7. The recoil of a 6-inch B. L. R. is restrained by an hydraulic cylinder alone. Weight of gun and carriage 13,000 pounds, projectile 100 pounds, charge 50 pounds, and value of $C = \frac{1}{2}$. Initial velocity of projectile 2000 f. s. Effective area of piston 30 square inches. Weight of cubic foot water 62.5 pounds, and recoil to be limited to 20 inches. The pressure is to be *constant* in the cylinder, and the aperture of escape of liquid *variable*. 1st. What is the initial area of aperture? 2d. What is the area when the gun has recoiled 18 inches? and what is the pressure in the cylinder?

8. A navy regulation target presents a vertical triangular surface h feet high and $2b$ feet base. The extreme errors of a gun are m and n feet horizontally and vertically respectively: what is the probability of a single shot hitting the target when the mean point of impact is taken at the middle point of the water line?

9. How may the principles of probability be applied to regulate the fire of guns on board ship? Of 15 shots fired at target practice at a supposed range of 1500 yards, four fall short and five to the right. The mean error in range is 85 yards, mean lateral error 10 yards, and the radius of the gun 50″. How should the sight-bar be set, and how should the sight-notch be moved in order that, in the next series of rounds, the point of mean impact and the target shall coincide?

10. An enemy's vessel has two exposed guns, each of which with its crew presents a vertical rectangular target six feet high and eight feet wide, and both are on the same deck. The targets are 36 feet apart, thus, 6′ | 8′ | .....36′..... | 8′ | 6′, and the mean errors of two Hotchkiss guns, which are directed to fire on them, are in direction 10 feet and in height 6 feet. Which of the two following methods, at the range used, will show the greatest probable number of hits on both targets after a given time—viz., to direct the fire of one Hotchkiss gun against the middle point of each target separately, or to direct the fire of both guns at the middle point between the two targets, with a chance of hitting either? Each Hotchkiss gun fires in the same time the same number of rounds, and the mean point of impact is assumed to coincide in both cases with the point at which the fire is directed.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE USE OF ONE ANGLE IN CURVED CHANNELS.

By Commander H. C. Taylor, U. S. N.

Before describing the "use of one angle in curved channels," it may be well to say that the principle is a very old one. It has been applied in different ways, and is used in the "danger angle," mentioned in *Sailors' Horn Book* and Harrington's *Navigation*, and is well known to all navigators. The principle used in navigating narrow and curved channels is the same as the danger angle, but applied under slightly different circumstances. It is the danger-angle idea somewhat amplified. It had been used in the C. S. Steamer Hassler and in the U. S. S. Saratoga for several years of occasionally difficult navigation and piloting, when it occurred to me that its use was not general in the Navy; and finding, upon inquiry and discussion, that it was but little known or used for curved channels, I described to the Department the convenience I had found in employing it, and suggested further trials of it at various entrances on our coast. A Board appointed in the Navy Department to examine the subject reported favorably as to its probable value in practice.

This method is applicable in entering many of our coast ports. Among these may be named: Portland, Salem, New Bedford, Oyster Bay, Sandy Hook, Patuxent River, Key West, and others. At Sandy Hook, where the ranges are, most of them, a long way from the channels they mark, slight mists are sufficient to cause them to be obscured, and at the same time to cause confusion as to the buoys; while a curve passing through Highland Light and Scotland Light Ship may be found useful to carry a ship safely from the Scotland around the Hook, and into the anchorage inside the Hook. And if this method should find favor, greater security and convenience could be reached by the erection of one or two beacons at suitable points of a good curve. The reef at Key West offers several examples of curved entrances of much safety and convenience.

The principal objection to the general use of this method is the ignorance of the use of the sextant and of the measurement of

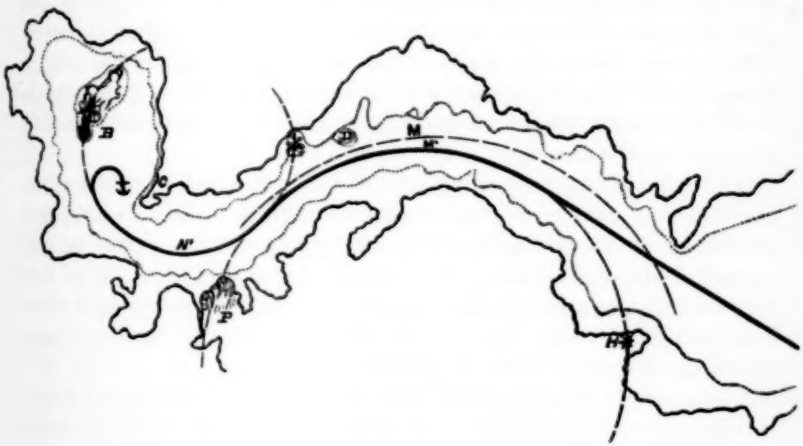
horizontal angles among a majority of seamen and officers in the coasting trade and merchant service. Here, again, if this method proved useful, a simple and cheap instrument could be made, without a movable arm, and registering permanently one angle—namely, the angle of two known objects in the vicinity—which, being kept at the proper number of degrees, would ensure a ship being on a safe curve. The objects and their proper angle being carefully determined practically for each port, these simple instruments would be constructed bearing the names of port and of objects used, and the number of degrees of angle.

All these matters are consequent upon the method being found useful; and I recommend the use of this method to officers, not as being certainly valuable, but as worthy of being thoroughly tested. I have had occasional incomplete trials of the method at San Juan de Porto Rico, Key West, Oyster Bay, Sandy Hook, and on the Pacific Coast, but have been at those times engrossed with survey work or the training of apprentices, and unable to give sufficient attention to the method. It should be understood that no new principle is claimed, and the only point specially made is that its application to curved channels may be found, in certain ports, very useful and convenient.

Upon approaching a harbor or channel where piloting becomes necessary, and where this method promises to be of use, identify on the chart some prominent points or objects in the vicinity of the curved channels to be followed. Then note what general curve the ship's course will have to follow in the channels, and describe roughly a circumference, of which this curve shall approximately be an arc, and which circumference shall pass through two of the prominent points or objects recognized on the coast. A headland, or simply a marked bend in the land, may be used in default of better-defined objects, the angle being taken to the tangent of the point, if the bends or profiles are sufficiently salient to prevent large errors by the change in the point of tangency as we advance. It is rare, of course, to find the exact curve desired, but by trying different known points on shore, and different lengths of radius, a convenient curve can be frequently found which will answer all the purposes of safety. This being done, draw lines from any one point of the circumference to the objects through which the circumference has been passed. The angle made by these lines will be constant for all points of the curve which lie in that arc of the circumference, as all angles in a circumference subtended by the same arc are equal, and as this angle will

in all cases be subtended by the opposite arc connecting the two points.

Thus, if a ship so direct her course as to make this angle (between the two objects) the number of degrees required, and keep it unchanged, or nearly so, she will be constantly on, or nearly on, the circumference referred to; and, as the angle becomes less, she will know that she is passing outside of that curve, and, as it becomes greater, that she is passing inside of it. If we have to round shoals in entering a harbor, *B*, we make, first, satisfactory curves for the



ship to describe in clearing them, such as *M;* then seek for a circle whose arc shall approximate to this curve and which passes through two prominent points, or any objects readily recognized, such as *H* and *P;* such a circle would be *M'*. At any point on the arc between *H* and *P*, lines drawn from *H* and *P* to meet in the circumference will make a certain angle—103° in this case. Hence, by approaching these two objects on a safe bearing until their angle, as measured from the ship, becomes 103°, we will find ourselves upon this safe and convenient curve, which we may follow by edging out when we increase our angle above 103°, and by edging in as it becomes too small. The same way with the next curve, and so on throughout.

There are many cases where the shoal does not discover itself by breakers or discolored water, and when distances from the shore must, without this aid, be judged by the eye—a dangerous plan for strangers unaccustomed to the appearance of the shores, heights of cliffs, and

such details. In such cases, if recognizable ranges back of the anchorage *B*, or of the point *C*, are not to be found, the convenience of this one-angle method becomes apparent; while, if to these circumstances we add the existence of a shoal *D*, or of rocks, as shown on the side of the channel, this method becomes more than convenient, being a valuable guarantee of safety. This is especially true when, in narrow waters and sharp bends of channels, time will not permit of bearings of objects being taken and plotted (the ship might ground while waiting for a position); and a principal virtue of this method is that the chart-work proper is done beforehand, and the officer is left free to handle his vessel with this check and guide always at hand. The sextant, set to the angle required, may be used by the officer himself who is conning, or by his assistant, and the ship may thus with ease and confidence be steered upon a safe and convenient curve or succession of curves.

The principle already mentioned can be extended by the further use of other objects on the same side, defining other curves and making a continuous safe course throughout. Also, if the proper course becomes of reverse curvature, objects on the other side of the channel may be used for defining by their angle a reverse curve for continuing the course; or such reverse curve may be used as a help to the first curve in a difficult passage.

The centre and radius of the required circumference are best found by inspection. Let the eye determine roughly the kind of curve needed to pass comfortably through the dangers; then sweep the arc most like that curve, using the centre and radius which seem needed for it; then search in the vicinity of that portion of this circumference which passes over land and among known objects for two suitable points. Having found these, endeavor so to adjust the centre and radius that the circumference, while fulfilling its office as a safe curve through the dangers, shall also pass through these two points. There will be found, as a rule, but little difficulty in doing this in cases where this method is useful. The angle made by lines from the two objects to a point in the circumference should be between 40° and 140°. It is not so reliable between 20° and 140°, and between 140° and 160°, and it had better not be used when less than 20° or more than 160°.

Should this method, in practice, find favor among officers, and be approved by the Department, the labor of inspecting the charts, describing the most convenient and useful curves, and providing rules for following out these methods, would naturally fall upon the

officers who superintend the preparation and issuing of charts, and would simply be an *addition* to the sailing directions of certain ports where this method promises usefulness. It should be tested practically at the place before directions are written. The work of inspection of the chart beforehand, and of preparing the curve, would not be required of the navigating officer of the vessel, who would only need to accustom himself to the measurement of horizontal sextant-angles. It is also probable, in the case of this method being favorably considered, that beacons or other marks for day or night would be erected in such localities as do not offer at the proper vicinities prominent and distinctive characteristics for use in defining by their angle convenient curves for piloting through a channel.

This method is productive of much satisfaction in the advantage it gives of being able to take the sextant or similar instrument with which one's position or curve is to be determined, to all parts of the ship and use it aloft or on deck with equal ease and accuracy. This advantage of the sextant over the compass is very marked when distant lights or other objects are shut out by mangrove swamps or scrub growth on flat lands, making them invisible from deck, but in sight from tops of an ordinary vessel. Such ports as Key West and Charleston, S. C., are instances of the above.

It may be well to state that this plan cannot be of service in piloting through straight channels, in which ranges and bearings are alone of service. It is useful only where the course to be steered is curved; nor is it of use when this curve is very slight, as in such cases the angle of the objects would be too great or too small, or their distance too great for accuracy.

Many harbors do not need curves of this method, being already well supplied with range lights, day marks, etc.; and it is not intended to be understood that this method should supplant other methods of running on ranges, bearings, etc., but only that it may be a valuable auxiliary to those methods on some charts, and an invaluable substitute for other methods on charts which do not possess the proper lights and ranges, and where curved channels have to be followed.

The writer of these notes is, however, disposed to believe, if the method be found worthy of adoption, that, in many already well-lighted and marked harbors, economy in the number of marks will be obtained by substituting this method in certain cases. An example of this is to be seen in the main ship-channel near Sandy Hook, where by using this method one lighted beacon at the "Dry Romer" would make unnecessary the following—viz.: West Beacon,

Bayside Beacon, and Wilson's Beacon. But the writer wishes to disclaim any intent to propose any changes in existing methods, and brings forward this notice only with reference to its auxiliary character in most ports, and to its own intrinsic value in other cases of ports not marked or lighted properly, or perhaps not at all — such, for instance, as San Juan de Porto Rico, where the writer has found the method very valuable at moments quite critical from a piloting point of view.

Application of the One-Angle Method to the Chart of Sandy Hook.

The chart of Sandy Hook entrance shows (see plate opposite) a curve marked *A*, defined by preserving the angle of 46° between Highland Lights and Scotland Light Ship. This curve carries 23 feet through South and Main channels.

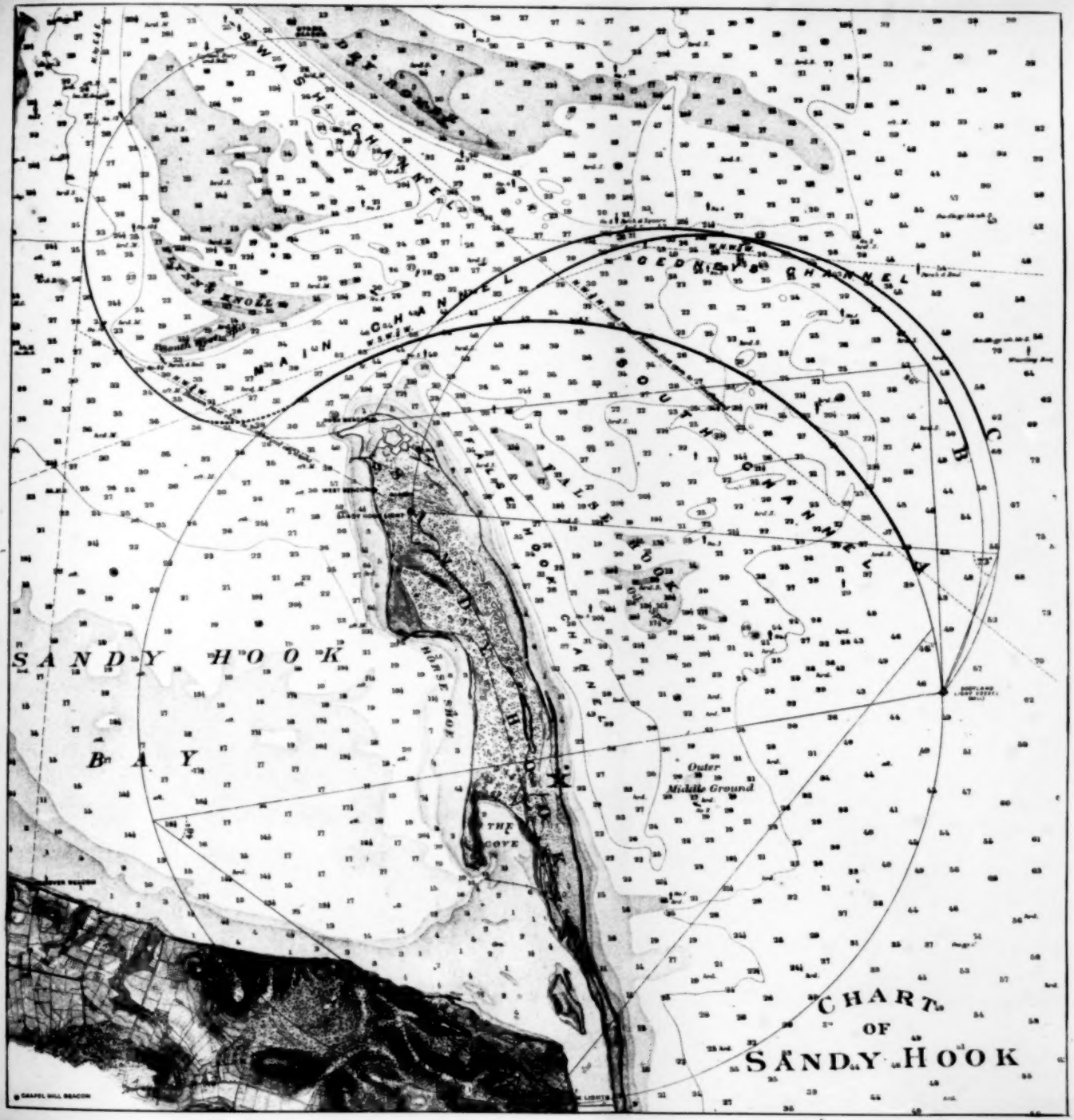
Another curve marked *B* is defined by an angle of 86° between Hook Beacon and Scotland Light Ship, and carries 24 to 25 feet through the Gedney channel.

Another marked *C* is defined by an angle of 73° between Scotland Light Ship and Sandy Hook Light, and carries the same drafts through the Gedney.

Many other convenient curves suggest themselves here, by the use of the lights, light ships, and beacons already in place, and the erection of one or two more beacons in suitable places at slight cost.

The distance of the range beacons from the vessels using them causes them, in most weathers, to be of little value, and it would be a satisfaction to the navigator to have close at hand, upon Sandy Hook, large, easily seen guide beacons by day, and bright guide lights at night. For instance, the curve marked *C* through Gedney's channel could be followed with ease and exactness by erecting a beacon at a point on the southern part of the Hook, which I have roughly marked *X*, and keeping the angle between it and Sandy Hook Light 32° (about).

Entering by Gedney and Main channels, when we consider the search for entering buoys at night, the compass courses, influenced by currents of which we are ignorant, and the ranges of far distant lights, usually confused by mists, such an accurate and convenient method as here described will seem preferable to many, especially to those to whom the rough measurement of angles is not a mystery.


SANDY HOOK
BAY
MAIN CHANNEL
SOUTH CHANNEL
GEDNEY'S CHANNEL
Outer Middle Ground
THE COVE
CHART OF SANDY HOOK

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE MONITOR WEEHAWKEN IN THE REBELLION.

By B. W. Loring, Late Lieutenant, U. S. N.

The following letters of Mr. Loring, being replies to inquiries addressed to him, are now published with his permission. These letters are so graphic, and so clearly describe the peculiar nature and dangers of the service upon which he was engaged in the Weehawken, that it has been considered better to publish them as they stand than to attempt to draw from them the material for a more connected essay.—Editing Committee.

Gentlemen:—The request that I should furnish an article of my experience and observations while on board the Weehawken during her service in the late war—her behavior at sea, the life on board, the manner of handling her guns, and an account of her engagements—I am happy to comply with.

On January 21, 1863, the Weehawken left New York for Norfolk, Va., in command of the late Rear-Admiral John Rodgers, and during this passage encountered her first storm, which nearly terminated her career at its commencement. Arriving off Sandy Hook in the afternoon, it was apparent that an easterly storm was gathering; but having received orders to proceed, if possible, we got under way, were taken in tow by a small, side-wheeled steamer, and, accompanied by the Iroquois, put to sea. The wind continued to increase, and as night approached was blowing a moderate gale. The towing steamer plunged heavily, and made signal of distress. She was ordered to cast off and seek a harbor. We understood she reached Delaware Breakwater in a sinking condition. The sea commenced washing over the deck to a considerable depth, and developed numerous leaks, small individually, but large in the aggregate. The centrifugal pump was not finished, and we were obliged to depend entirely upon the ordinary bilge and hand pumps, which were incapable of discharging the accumulating water. At 2 A. M. the 22d, the engineer reported "the water nearly up to the fires, and only ten pounds of steam on." By extra exertion, steam was sufficiently increased to work the pumps more rapidly. At 4 A. M. signal was made to the Iroquois advising her of our dangerous condition, but she could render us no assistance in that heavy sea. All that could be seen of us was an occasional glimpse of the small light that

hung from the staff above the turret, and each disappearance below the crest of the waves it was thought would be final. During this time, by increased working of the pumps, the water had been kept down, and at daylight the wind had moderated, and continued to decrease until all danger was passed. By noon, with some difficulty, we were able to take a hawser from the Iroquois. At night we passed Cape Henry, and anchored in Hampton Roads. The anxieties of that night can never be forgotten. In speaking of it afterward, Captain Rodgers said, "It added one year to my age."

Previous experience on board this class of vessels would have enabled the officers to prepare better for heavy weather; the numerous openings liable to leak would have received attention, not being difficult to close in smooth water, but inaccessible with the "green seas" sweeping over the deck. The principal leak was at the turret base: a small quantity of water entered at the hawse-pipe, and some around the hatch coverings. During the gale the vessel was kept upon her course, following the light of the Iroquois; the combs of the sea swept the deck, but not the turret top: only occasional sprays were thrown over it. The experience of this passage was used in preparing for the next one. The centrifugal pump was completed; places where leaks had developed were carefully attended to. A rope grommet (a rope with an eye-splice in each end hove taut with a lanyard) was tightly drawn around the turret base.

On the first day of February, in tow of the steamer Lodona, we proceeded again to sea, bound for Port Royal. The Lodona was an English propeller captured at Ossabaw Sound while attempting to run the blockade, and was supposed to be capable of withstanding any storm. We encountered a gale from SE. when off Cape Hatteras, during which the Lodona was unable to steam ahead, and being compelled to lie-to, it was considered best to cast off the towing hawser. This was ineffectually attempted at our end, and a courageous seaman volunteered to cut it. With life preserver and bow-line around him, he reached the bow, and, between the seas that washed over him, essayed several ineffectual strokes; but, losing his axe, was dragged back exhausted to the turret. Captain Rodgers refused to permit the end at the Lodona to be cast off, there being danger of its fouling our propeller, so the vessels remained attached during the gale. No inconvenience was felt from leaks, as the centrifugal pump now cleared the hold of water. The new engine, not having been thoroughly tested, caused us some anxiety, and when within one and a half hours' run of Port Royal the cylinder head broke into fragments. The Lodona, however, towed us safely into port.

I have been explicit in describing these storms, that their severity might be comprehended. The behavior of the Weehawken was admirable, fully establishing the ability of her class of vessels successfully to combat severe gales. In lying-to, her manner was as different from that of the usually modeled sea-craft as there is difference in their models. Her easiest and safest position was to lie in the trough of the sea, rather than head to it, as she rolled like a raft, making splendid weather of it. Her motions were remarkably graceful and easy, and no precautions were necessary to secure the table crockery. The area of surface exposed to wind was small, and her drift to

leeward was unusually slight. The second storm was much more severe than the first, but, being properly prepared for it, and the centrifugal pump being able to discharge all incoming water, we passed through it successfully. In this, as in the previous storm, the heavy seas swept over the deck, and only spray over the turret top. At sea, the anchor and propeller wells are uncovered, leaving a free passage for water. When in tow, this open anchor well, on account of its close proximity to the check through which the towing hawser leads, is a great source of danger to life and limb, as one is liable to be swept into it while examining the hawser for chafes. A life line stretched from the turret to the bow is a necessary precaution, as the combers that sweep the deck, although appearing light, are deceitful.

While upon this subject, permit me to suggest that the sea complement of officers should be in excess of the usual number, as the disability of one or more officers would materially increase the duties of the remainder, and this condition of affairs is very likely to occur. For example, one night, while lying at Norfolk, an alarm that "rams" were coming down the James created a commotion, during which Captain Rodgers was severely injured by stepping into the propeller well. It was two weeks before he was sufficiently recovered to appear upon deck. During this time the executive officer was confined to his room by sickness, another officer, while examining the towing hawser, was swept into the anchor well, went through and came up outside, and was dragged on board severely bruised, rendering him unfit for duty. In this way the complement of officers was reduced from five to two. Consequently, the duty of taking the ship from Norfolk to Port Royal devolved upon the remaining two officers.

The Weehawken's engagements with Forts Sumter and Wagner, and the Sullivan's Island batteries, were numerous, but only those wherein her services were conspicuous need be mentioned. On April 7th, arrangements were completed for an attack upon Sumter. Orders were given to get under way at 2 P. M. The Weehawken was designated to lead the line of battle. Mr. Robert Platt, a gentleman connected with the Coast Survey, and thoroughly acquainted with the topography of the harbor, gallantly volunteered to take the responsibility of piloting us into the engagement. We were provided with a "torpedo catcher" (a raft with trailing grapnels), which caught our anchor chain, detaining us two hours, and proved of no benefit to us. While steaming up the harbor, the following instructions were given the crew of the turret division: "Should we be struck by a torpedo, not a man shall leave the turret until every avenue is free for the escape of your shipmates below deck. Open the slides above; throw back the port-stoppers; run in the guns, should they be out; open all gratings under your feet; then you may leave the turret, not before."

As we approached Sumter, suspicious-looking buoys, indicating torpedoes or obstructions, were reached; the advisability of passing them was considered by Captain Rodgers, and the conclusion arrived at was thus expressed: "Torpedoes! Well, heaven help us if they are, for I am going over them." A few moments later a torpedo exploded alongside, throwing a column of water into

the air, but only jarring the vessel. Having steamed a few hundred yards beyond, it became evident we had reached the focal point desired by the enemy. The initial gun was fired from Sumter, and the first shot struck our turret; then from all directions came a shower of shot and shell; turret, pilot house, smoke stack, side and deck, all came in for their share. We opened fire, still advancing toward Sumter, and were enveloped in smoke and water. General Hunter, who witnessed the fight, in a letter to Captain Rodgers thus describes the scene:

"The Weehawken opened; she was enveloped in smoke and water; we saw the shot like hail flying upon and around her; she was for a moment invisible. Nothing can stand such fire. We held our breath; she came to view and fired again; three cheers, and we breathe freely again." Meanwhile, "we can see nothing: Sumter is invisible; the enemy's shot is throwing water in torrents over the turret; the gun vents are covered; we are not drowned, but very wet. For nearly half an hour this concentrated fire was upon us; we had fired two rounds, and were prepared for the third, when the engagement became general. After an engagement of two hours the signal 'Withdraw from action' was given."

During the concentrated fire, a large shot struck the gun-metal base rim of the pilot house, and breaking out a fragment, jammed the turret, and caused difficulty in revolving it. A few revolutions, however, relieved it. After the action the shot was found upon the turret top, slightly flattened, but unbroken.

To prevent the entrance of broken shot and other substances at the turret base, a hawser and smaller rope had been drawn around it above the plate rim, and after the engagement became general, a hasty examination outside found these, and the rim also, severed, making an opening into which the small rope was tightly jammed. As this was liable to interfere with the working of the turret (unsuccessful efforts having been made from the outside to free it), it was passed in, and finally disengaged by attaching the shot tackle.

The effect of this engagement upon the Weehawken was slight; for although between fifty and sixty shots were marked upon her, no serious damage was received. Numerous bolts in the turret and pilot house were broken, one in the pilot house breaking through the sheet-iron lining. This lining, an idea of Captain Rodgers, was put in at Port Royal at his suggestion, and no doubt was the means of saving life.

The monitors Nahant, Weehawken, and gunboat Cimmeron, on June 17th, were lying in Wassaw Sound, with banked fires, and cables prepared to slip, waiting to intercept an iron-clad ram, reported at Savannah, and about ready for sea. The previous afternoon, four discharges from heavy guns were heard, which came from the Atlanta, who was scaling her guns. The Atlanta, commanded by Captain William Webb, was the English blockade-runner Fingal. She was reconstructed at a cost of about a million dollars, furnished by the ladies of Savannah from the sale of their jewelry and silver, and so bore the name of the "Ladies' Gunboat."

While steaming down the river, they spent the night in making ready for the morning attack. At daylight three steamers hove in sight. The order "Spread

fires, beat to quarters, clear ship for action," caused an amount of activity that in ten minutes found us fully ready for business. Lying in a narrow channel, and heading down the sound to a strong flood-tide, necessitated our steaming into wider water to turn to meet the coming ship (the other two steamers, loaded with spectators to witness the fight, remained above). Meanwhile several shots were fired from the Atlanta. While turning we dropped our small boats with a kedge, and when within three hundred yards of her opened fire. The XV.-inch shot struck at the forward end of her casemate, smashing a hole 3 feet by 1½; it was then deflected by the angling side and, passing over, struck a pile of lumber stowed upon the casemate, filling the air with flying boards, and giving us the flattering impression that the whole institution had "gone up." Two guns' crews were wounded by splinters, and prostrated by the concussion. In two and a half minutes a second round from both guns was fired. The XV.-inch missed, but the XI.-inch struck the top of the pilot house, wounding the three pilots, and piling them upon the trap-door, the only entrance to the pilot house. This left the Atlanta without helmsmen, and she went aground upon the shoal along the edge of which she was running. Another round was fired by us from both guns, one shot tearing away a port-stopper, the other striking the knuckle of the overhang. The Atlanta then surrendered.

The Comte de Paris, in his work upon our "Civil War," and also the correspondents who reported this engagement, stated the guns to have been "fired by Captain Rodgers." As officer in charge of the turret division, all guns were fired by myself, while Captain Rodgers occupied the pilot house, attending to the duties devolving upon the commanding officer.

On July 6th, Captain Rodgers was detached. He was a noble man, extremely modest, honorable, and brave, having no superior. His detachment was sincerely regretted by all.

During the night of September 6th, the Confederates evacuated Fort Wagner; on the 7th we were ordered to sound and buoy a shoal channel near it and Sumter, in attempting which we grounded. By signal the Admiral was informed of our situation. After dark a tug with anchor and hawser was sent to our assistance. Throughout the night we were engaged in transferring shot to the tug. At high tide all efforts to move the vessel were unavailing, and daylight found us still hard aground, with a falling tide. The tug returned to the outer harbor, while we quietly awaited developments. At 8 A. M. the receding tide exposed our hull, and the enemy discovered we were aground. The batteries of Sullivan's Island opened upon us, expecting to strike our hull. We returned their fire, aiming entirely at Moultrie. The second XV.-inch (a ricochet) disabled a gun, and exploded their magazine, throwing its contents high into the air, making an admirable exhibition; sixteen men were killed and twelve wounded. The signal from the Admiral, "Well done, Weehawken! Don't give up the ship!" was a source of encouragement at this time. The unequal contest was continued for an hour, until relieved by the participation of the other iron-clads, which had been ordered to "cover the Weehawken." They engaged the batteries until the tide had partially submerged our over-

hang, when they withdrew, leaving us in a safe condition. Again, at high tide, we renewed our efforts to float, applying a tackle to the hawser. All available men on board, including firemen, coal passers, and idlers, were pressed into this service, making a large appearance of men on deck, and they drew the enemy's fire once more, but we made no reply. The movements of the men were directed from the turret top, as from there they could be warned to collect under its shelter as the well-aimed shots approached us. Ensign Chadwick saved his life through his agility in throwing himself over the side, holding by one hand and foot, while the ball passed over. The same ball was dodged by the boatswain's mate, who threw himself flat upon deck. One shot struck the turret top, which I escaped by stepping aside, while it passed directly over the spot I had left, breaking a beam of railroad iron into three pieces, and wounded three men who were skulking within the turret. Notwithstanding this iron storm, our labors were successful at high water, and, as we swung outward, the hawser was cut, and three cheers were given; after which we went to quarters and gave Moultrie a parting round as we steamed away, with only one small leak in our hull.

Our life upon the Weehawken was certainly uncomfortable, and at times extremely so, especially while lying in the outer harbor at Charleston; then an easterly wind caused sufficient swell to compel us to close the hatches. This produced foul air and unendurable heat below. A letter written on board at the time says: "Have been confined below eight days; our food, canned meat heated by the furnace fire." Again: "I am writing this with a towel tucked under my chin, to absorb the perspiration that is streaming from my face." The turret top in good weather was a favorite resort for sleeping, even the perforated iron, with blanket and rubber coat, being preferable to the closeness below; and it assumed quite a literary appearance when the signal was made, "Opportunity to send letters," for writing then became the order of the day. It was also resorted to by the officers when off duty, who whiled away the interval in discussing current events, or in watching with binoculars the effect of exploding shells upon the walls of Sumter. The "wedging up" of the turret was a notable incident of life on board; the resounding thud and the resultant vibration could be heard and felt throughout the vessel, and denoted business. It is possible that many are not aware that a monitor's turret is so constructed that while making passages at sea, or lying in friendly quarters, it rests upon its base. When preparing for action it is raised slightly until its weight rests upon the spindle. To accomplish this a wedge, sufficiently strong to support the enormous weight of the turret, is used. This is called "wedging up." As an appropriate summary of "life on board," I will say there was constant employment, physical and mental, for all classes. Confronted as we were by an active enemy, ceaseless vigilance was required. The responsibility vested in commanding officers of our vessels in front of Charleston, was a strain upon the nervous system which is undoubtedly felt to-day by many, and has shortened the lives of others. Officers of all grades were unable to endure these hardships and discomforts, consequently, changes were of frequent occurrence. It must be borne in mind that, through the exigencies of the time, the crew were

for several months pent up on board, and deprived of the liberty allowed them while lying in port. This privation, in connection with their daily labors, will account for the fact that generally there were several men sick in the hospital. Finally, in comparison with the comfortable quarters usually provided the officers and crew on board our naval vessels, those on board of a monitor appear to a disadvantage, and would be desirable only to one willing to sacrifice personal comfort to patriotism.

I was detached on November 4, 1863, after a service of ten months, and about a month later, December 6th, the Weehawken foundered at her old moorings in Charleston Harbor, which loss, in my opinion, was caused by very injudiciously loading her by the head with shot.

Very respectfully, B. W. LORING.

OWEGO, TIOGA CO., N. Y., *November* 27, 1885.

GENTLEMEN :—Your communication of the 17th November is received. The action between the Weehawken and the Atlanta has left a very vivid impression. The guns in the Weehawken's turret were an XI.-inch and a XV.-inch, and were under my command during nearly the whole service of that vessel, as she was sunk thirty days subsequent to my detachment, and my service on board commenced before she was out of the builder's hands. I know of but one shot having been fired that I did not sight. The first captains of the guns pulled the lock-strings at my order "Ready, fire." I never used the sight-vane, which was situated near the port of the XV.-inch gun, but sighted over the XI.-inch as a sight for both. That was preferable for two reasons—one, that I could stand either side of the breech and watch the object to be fired at; the other, that I could stand nearer the engineer who governed the turret machinery, and could thus control his movements more perfectly. Through practice, we were often able to stop the turret upon an exact aim, and the order "Stop, ready, fire," came together. As the object approached the line of sight, by the motion of my hand the engineer gradually slowed to a stop.

The distance was obtained by *estimation*. It was Captain Rodgers' intention to waste no ammunition at long range; therefore, he gave the order to elevate slightly. The order "Open fire" was not given until within *certain*, point-blank range. We used thirty-five pounds of powder, never more, and cored shot (four hundred and fifty pounds, I think), for the XV.-inch gun; and for the XI.-inch, the ordinary charge of powder and solid shot. We exercised daily at the guns, the only previous fighting exercise being at the first attack upon Sumter, April 7, 1863, when the Weehawken led the line of battle, and I had the honor of sighting the first shot at Sumter after its capture by the rebels.

A few details regarding the working of the guns and turret may interest you. While I was upon deck attending to details left undone, in the hurried clearing ship for action, the guns were loaded under the supervision of Lieutenant-Commander Cornwell, and when I entered the turret we were quite near the Atlanta. I had scarcely reached my station when Captain Rodgers gave the order to "open fire." The thickness of metal at the breech of those heavy

guns is so great that the primer frequently lacked force to reach and penetrate the cartridge, consequently, the captain of the gun was provided with a small flask of fine powder to prime with, but was not expected entirely to fill the vent. That is what they did, however. The primers could not be inserted. Without mentioning their error, I was told the primers would not enter. Discovering the cause, I gave orders to cut off the quill close to the wafer. While the captain of the XI.-inch was doing this, the XV.-inch was announced as ready. We were three hundred yards distant from the Atlanta. The shot struck near the forward end of the armored casemate, in the vicinity of two guns' crews, who were prostrated, and many wounded, by the concussion. The iron armor and angling side deflected the shot, which passed over, smashing a hole entirely through her side, nearly large enough to pass a barrel by ending over. Having reloaded the XV.-inch, and maintaining the same elevation, *both* guns were fired. The XV.-inch shot missed (the only one that did miss); the XI.-inch struck the upper edge of the pilot house, throwing fragments of iron upon the heads of the pilots and felling them upon the trap-door, through which entrance was made to the wheel, effectually preventing ingress, and the Atlanta grounded upon the shoal near the edge of which she had been running. While reloading for a third round, the quartermaster reported that a white flag was waving from the Atlanta. Captain Rodgers, being unable to see it, ordered the firing to continue. Another round of two guns was fired (making a total of five shots); both shots took effect, the XV.-inch upon the knuckle, the XI.-inch three or four feet higher, tearing away her heavy port-stopper that was hung upon the outside. The quartermaster again reported a white flag upon the Atlanta, which could now be seen distinctly, and we ceased firing.

The distance was slightly increased between the second and last rounds. I have given you all the information requested regarding the battle, but will add something about our *method* of working the guns and turret. Our fire was rapid for a monitor, and I will explain how it was obtained. During our first fight with Sumter, the service of the guns was torturingly slow, under a return fire that is seldom equaled. (The shot pelted us, and the water near us, which latter was thrown over the turret top, falling down upon us like a rainstorm, compelling the captains of the guns to cover the vents.) The time required to load was between six and seven minutes.

Several days after, I devised that *traveling bar* which you will find in the turrets of to-day; it expedited the loading and lightened the labor. At the same time, I invented a method of indicating to the engineer where to stop the turret that a clear opening might appear on both sides of the turret chamber, and that the powderman and tackleman might know which grating to remove, and also that the powder and shot passers below might know exactly where to stand, ready to hook on when the turret stopped. These men performed their different duties simultaneously, upon an order given by myself immediately after the discharge of a gun. No other sound need be heard save the revolving of the machinery. The turret stopped at the place indicated, the shot and powder whip dropped below at the first appearing of the opening, and the powder would be nearly up to the grating by the time the turret stopped. We never

used the port-stopper, but turned the turret one-quarter away from the object engaged, avoiding the necessity of using the sectional rammer and sponge, thus saving the time required to connect and disconnect them. The indicating method also avoided the outrageous confusion both in and below the turret, in the endeavor to find where the powder and shot were required, and the repeated request to the engineer to turn a "little this way or that" to make a clear opening below. While in battle, all openings upon the deck were securely closed with heavy iron hatches, difficult to open from below; hence, should the vessel come in contact with a torpedo, the readiness with which clear openings could be made to the turret chamber would greatly facilitate the escape of the crew to the outside. Again, having two classes of guns to handle is an element of confusion and delay in the chamber below, through the uncertainty of where the ammunition of each may be needed. This was also remedied.

Another benefit worthy of mention was that I was able to work the XV.-inch gun with only nine men in the turret, shot being hoisted by men in the turret chamber. In the contracted space of the turret we found this of great advantage. The XV.-inch could be served in nearly the same time as the XI.-inch, it being reduced from between six and seven minutes to about two and a half, making the service of our monitor equal to nearly three under the previous conditions. This fact can be verified by referring to the report of Admiral Dahlgren to the Secretary of the Navy: Navy Report, 1863, "Summary of Service of Monitors against Morris Island," etc. Making allowance for the fact that several of the monitors were called into action a greater number of times than the Weehawken, notably the Montauk, Admiral Dahlgren made the Weehawken his flagship, *during action*, early in the operations against Morris Island, and continued to do so during the attacks thereafter, for the reason (as he remarked) that we "fired more rapidly and with less noise and confusion than any other monitor." Chief-Engineer James G. Young, of the machine repair shop at Port Royal (an engineer on the Weehawken at this time), introduced the traveling bar into the other monitors, when placed under his charge for repairs, and, I have understood, claimed the invention. This may not be true, however.

If any portion of this statement is not fully clear to you, I shall be pleased to explain. You will see by the date that I have taken considerable time to complete this communication; being in poor health, I have been unable to apply myself continuously.

Respectfully yours, B. W. LORING.

OWEGO, TIOGA CO., N. Y., *December* 16, 1885.

GENTLEMEN:—Yours of December 10 is received, and it gives me pleasure to know that you found the account of the service of the Weehawken interesting. It has been equally pleasant to me to recall the stirring incidents of those days, and has not been of the least trouble. I have no objection to its being published, if you think it worthy of that honor, although not written with such expectation.

In regard to the sights and manner of using them, my memory fails me, and I can only give very unsatisfactory information. The XV.-inch was fitted with a trunnion level, but the XI.-inch was not. What it did have I cannot bring to mind. I know that I used the sight bars and level only to obtain the elevation, using the line of metal of the XI.-inch gun for the lateral training (not recommended to an unpracticed eye). In the action with the Atlanta the guns were elevated to 300 yards, and the first round was fired at that distance. The second (two shots) was fired with about the same elevation, but the distance was decreased slightly, perhaps twenty-five yards, causing the shot to strike higher. At the last round the distance was increased to probably 350 yards, which, with the same elevation, caused the shots to strike somewhat lower than either of the others. The cause of the variation in distance is accounted for in the following explanation, and was not intentional. When the Atlanta was discovered approaching from above us, in the indistinctness of early dawn, the Weehawken was heading down to a very strong flood-tide. Her cable was slipped, and she was run down some distance for a wider passage in which to turn, to meet the Atlanta face to face. The channel being narrow increased the strength of the tide; therefore, when our fire opened, at 300 yards, but a short time was required for the tide and the momentum of our vessel, together with the headway of the Atlanta, to sweep us abreast of, and at the last round considerably past, each other; for reversing the engine of one of those clumsy monitors under those circumstances had but little effect towards decreasing headway.

In the attack upon Sumter, April 2, 1863, the distance between the Weehawken and the fort, when fire was opened upon her, I can only imperfectly estimate. It probably was from 800 to 1200 yards; from Moultrie perhaps 1500. The other forts I cannot estimate. While the fire of all the forts was concentrated upon the Weehawken, before the action became general (she being in the lead), judging from the unceasing beating of projectiles upon the turret and hull of the vessel, and in the water alongside, there might have been at least 100 guns engaged against us. During this time there was a sufficient quantity of water thrown over the turret top to endanger wetting the priming—to prevent which the vents were covered—and the occupants of the turret, myself included, were wet, but not seriously, the opposing fire being soon divided among the fleet. You may imagine the pandemonium without, arising from the splashing water, the impact of shot, which broke into fragments as they struck, and spattered an iron hail upon our iron deck.

Our engagements with the forts at Charleston were upon an unruffled water, and point-blank ricochet was my favorite method of shooting. The XV.-inch heavy shot and shell bounded beautifully over the surface of the water. In night-attacks, a much superior sight could be obtained with the eye near the port-hole. I was enabled to do this by lying prone upon the top of the gun, giving the command "Ready—fire!" as I sprang off.

Respectfully yours, B. W. LORING.

U. S. NAVAL INSTITUTE, WASHINGTON BRANCH,

MARCH 11, 1886.

REAR-ADMIRAL S. B. LUCE, U. S. N., in the Chair.

A VIEW OF OUR NAVAL POLICY AND A DISCUSSION OF ITS FACTORS.

BY WM. BAINBRIDGE HOFF, Commander U. S. N.

It has always struck me as very odd that officers of our Navy and members of our maritime communities have not thought more, or at least have not expressed themselves more in the public prints, upon a science which, even at this present time, has a large mass of literature of its own. Men in foreign navies, and tacticians who are not naval, have devoted themselves, year after year, to classifying and arranging the conclusions reached by experiment; and in no branch of this science which I term "tactical," has more satisfaction been reaped than in arriving at decisions in regard to what is needed in the way of vessels for defence. Given a coast, what is required to defend it? Or even given a country, what navy is required to protect it?

The next question, Given a locality, what navy is necessary to subdue it? is more complex, since we very well know that certain forces of vessels will be required for certain localities, and that a navy could not be built to suit each one, and then be put away and labelled, only to be used when such locality was to be acted against. Therefore, for us in this country, this part of the tactical question must be modified so as to stand something like this: A naval defence being provided, what foreign cruising navy is needed to protect each dollar of American capital floating foreign; what naval protection is required to make this coin breed fastest, and what ships are necessary to keep our *personnel* in the highest condition of efficiency? In regard to this last, it may be said right here that the requirements of the modern vessel are such that the commanding officer will have his *overalls* on two days, to one that he will wear his epaulettes.

Coming back to the first question, What is required for the naval defence of a country, we are immediately met face to face with several unpleasant facts, but none more unpleasantly prominent than the fact of the unconscionably long time it takes to put a ship afloat in fighting trim. In old days the great gun was described as a hole with molten iron poured round it; and four months before the lordly frigate sailed on her mission of war, her whole fabric was perhaps sheltering the piping shepherd and his flock on some quiet hillside. This question of time, however, is the worst side of the case, and if three years are now demanded to build a line of battle ship, we have this recompense, that Tactical Science, if we go to her, will tell us exactly what sort of a vessel to build.

Naval Tactics, as I have hinted, has now its laws laid down with more or less precision, and it only awaits the action of the practical student to have them more fully codified. It is the mother science of naval warfare, since it instructs us how to measure a locality for its defence in the same way that a tailor measures us for our clothing. Or, if this is not taking high enough ground, it may be stated that the tactician can write out a prescription for defence in the same manner that a skillful oculist writes a formula for a pair of glasses for his patient's eyes. In each case the elements of weakness form the basis for determining the protection.

I am well aware that I am using the word *tactics* in an unusual sense; still, I venture to give my reasons for differing from the ordinary military definition. For instance, Jomini says that tactics is an *art*, and deals with the proper use of masses—either on the drill ground, away from the enemy, when it is termed *minor* tactics, or in an engagement with the enemy, when it is termed *grand tactics*.

Between military and naval tactics there is, as it were, a perfect identity, and yet a radical difference, as will be seen by the following illustration. A general combines his fighting factors, just before or during a battle, to suit the conditions which will, as far as his insight goes, either compel victory or avert disaster. Thus he places certain guns, or certain squadrons of horse, to cover such-and-such bodies of foot. When he has done this, he has established certain self-supporting *nuclei*—units—which, if they remain intact after the combat begins, are permitted so to remain; if, however, they are destroyed, or the balance is broken up, the combination is perfected by supplying from a reserve the defective arm, whichever it may be—cavalry, artillery, or infantry.

With the naval tactician this same thing occurs. He also marshals his elements—the gun, the ram, and the torpedo; and he marshals them for one purpose alone—to serve in the line of battle in conflict with the enemy. Formerly, when all vessels were alike gun-platforms, with a common arc of fire, and were manœuvred by sails, the admiral could at a late hour begin to distribute his forces and dress his lines for battle precisely the same as if he were a general commanding troops. *Now* the tactical aspect of a war, the absolute fighting of a battle, causes the tactician, in order to be successful or prevent defeat, to see the need of certain combinations, such as gun with torpedo, torpedo with ram, etc., etc. These combinations are, of course, impossible for him to make after the *unit*—the vessel—is constructed, and, therefore, the *time element* enters to such an extent into tactics, when applied to matters naval, that the work of fighting the battle begins in the draughting room or shipyard, where I am going to take the liberty of putting it.

To state it more concisely, tactics begins with the formation of the *unit*. The army tactician can form his unit on the field of battle, while the naval tactician must begin this assemblage in the construction of the ship.

It is all very well to term tactics an *art*, since it is only the *application* of certain conclusions in regard to fighting; but back of it all is the science, which we term Tactical Science, and which I should define as the knowledge of the *requirements* of war for offence and defence; Tactical Art, as the proper employment of the elements of war combined in conformity with the conclusions of tactical science.

The question is naturally asked, How can these tactical measurements be made, which we referred to a few moments ago? The answer lies in the fact that nearly everything entering into the building and fitting out of a ship depends upon the most delicate adjustments and most refined results as regards mechanism. By the study of thinking, practical men, and in the case of our Navy, I am glad to say, by the enlightened work of our Naval Academy graduates, certain instruments of war are made to suit certain conditions. A certain gun is made to do certain work; for instance, some are armor-piercing, and some are designed for lightness and rapidity of fire. A certain hull is planned to stand best on such a coast, for such a purpose; a certain economy of deck space is best adapted to certain classes of vessels; and so on.

These materials being furnished, it is the tactician's province to

assemble them in obedience to the demands of the locality to be defended.

In the same way, in offensive foreign operations, the tactician puts together in the best manner all the factors of war which the specialist places in his hands.

The specialist must deal with questions in his line. If he is an ordnance officer, he must determine how to obtain greater muzzle-speeds with less chamber-strains for his guns. If he is a constructing engineer, he must strive to stow away a horse-power in fewer cubic inches. If he is a naval constructor, he will aim to accomplish the same strength of hull with less weight. What is true of these men is true of all others engaged in furnishing the factors for success of naval vessels in time of war. The tactician must not only put all these together in the best way, but he must draw up rules how they must be used to serve the intended end. It is his business to grow nuts for specialists to crack. He remembers that the question of time enters so largely as a factor in all preparations for warfare, *that everything must be used for its full value.* He must not install an armor-piercing gun in a vessel where it would be the remotest contingency for it to engage an armor-clad. He must keep in view the service upon which a vessel will be employed; whether its field of action is so far off that it will be hard to obtain coal or ammunition, or whether its cruising ground is in a locality where supplies are easily procured. Here will come in the question of sail power, coal space, and size of guns. In regard to this latter, it will be remembered by him that where a five-inch gun will do as well for the work in hand as a six-inch gun, he can carry two five-inch guns where only one six-inch can be taken; and where, with a six-inch gun, say only 500 rounds of ammunition can be stowed, with the smaller gun very much more than that amount can be carried. The tactician will find it especially hard work overcoming the prejudices of those who build our ships, or at least of those who heretofore have built them—men who never went to sea themselves—in regard to this matter of guns. Thirty years ago the gunboat was no more vulnerable than the frigate, and it was good sense to put in the gunboat the largest gun she could carry. Nowadays, we hear people, who should know better, boast that they are designing unarmored vessels to carry batteries of the greatest weight of metal, forgetting that these guns—very costly and made with a purpose—will never be used as intended. What is the sense of driving a tack with a sledge-hammer?

Right here would come in the canon that the defence should equal the offence as nearly as possible. If our guns are of good calibre, and yet are only protected by the paper-shelled side of a ship, they will not have justice done them in a fight, since their crews would be destroyed if it were attempted to employ them at their full value. These guns should at least have their crews protected against the fire of rapid-firing guns.

Again, another canon is that the thinner the protection, the more separated the guns composing the battery must be. This is comparable to separating into lines of skirmishers the ranks of soldiers, which, in days when arms had less precision, rapidity of fire and length of range, stood shoulder to shoulder.

These canons are the conclusions drawn from the experiences of navies—deductions found by assembling the factors of war in ships, and drilling such ships in fleets.

It may be said, too, that they are being continually violated, not only in our service, but in other services. This comes, I conscientiously believe, from a disregard or ignorance of the performances of ships in battle, and the conditions surrounding a contest with an enemy. These can only be learned by a close application to the study of naval tactics, the new seamanship, the naval officer's legitimate calling. The application of this study, which serves as the foundation for building up the great science of naval warfare, is the underlying idea in the establishment of the War College, and it rests with us whether or not this seat of learning succeeds in its endeavors.

In support of my conviction in regard to the tactician being the one to suggest how ships are to be built, I would beg leave to call your attention to a few facts in connection with a vessel now being built for the English Government—one of the few, I believe, where a person skilled in this science has had his views carried out. If I am not misinformed, I can associate the name of an Admiral of the Royal Navy with that of the Renown. Here is a ship of great speed—18½ knots; with double screws and therefore great manœuvring power, fitted for the line of battle, large enough to give a great, crushing blow with her ram; her vitals covered by a deflective deck, her sides belted with armor to resist heavy shot, and with two enormous guns forward, protected with heavy armor, to accentuate a ramming attack. This is common to many ships, but if we had the plans here to look at, it would be noticed that these guns are put in the vertical axis about which the vessel turns; the reason for this being that,

the larger guns are, the slower they will be served, and the fire, to be most valuable, must be most accurate. You will readily see that the nearer the guns are put towards the extremities, the more the steering enters as a marring effect to their precision of fire. To continue our description of the Renown: She has a battery of six-inch guns (note the small size), whose crews are protected from rapid-firing gun projectiles by light-armored sides and traverses. Again, these guns have a greater train aft than forward, which is novel, and would leave their mark on a ship which has just charged past. To this battery may be added a fairly heavy gun firing astern and an adequate secondary battery. See where common sense comes in, in regard to guns! We want weight of fire to supplement the ram—two 110-ton guns; we want rapidity of fire in broadside—comparatively light guns of only six inches calibre. As regards torpedo offence, she is as well supplied as, but no better than, many another ship. Viewed from the standpoint of a seaman, this naval man's ship stands pre-eminent. I do not for one instant say that we should copy her, but I only mention her as a floating tactical argument of the highest and most satisfactory class.

In point of fact, I cannot understand why a country should adopt such a naval policy, which, as far as her finances and the means at hand will permit, causes her to copy the navy of some other nation which leads in this respect. It is for this reason a navy is built without system, one set of legislators wishing to have big ships, and another set striving to carry a measure in favor of small vessels, ignoring completely the precept which forms the basis of good naval policy—that ships, like pegs, should be made to fit certain holes.

The British Navy, for example, is maintained under conditions in no ways applicable to those which surround ours. Because it is vital that Great Britain should have a certain number of armored vessels, it is no reason that we must build ships of like character. I do not say that we do not want armor-clads, but I have reference entirely to a blind following of characteristics and numbers. No two countries could be more unlike tactically. England's navy for defence is like the thread which unites the pearls of some rare chaplet; ours resembles more the setting of a single jewel. Great Britain is spread over everywhere; she must be nourished from outside; and she is moved by any political disturbance in Europe, Asia or Africa. We are concrete, self-feeding, and, from a tactical standpoint, invincible. Perhaps, of all countries, ours is the least difficult to decide what shall constitute its naval defence.

The war question ciphers itself down to this: Given at each point the amount of invested capital assailable by the enemy, what proportion of this amount shall be diverted to furnish a defence? To determine this, our coast would be divided into districts, as is done under the Lighthouse System, each division requiring, possibly, a different class of defence, involving the building of different varieties of ships. As the New York district requires more and better lights on account of its commercial importance, so it will have a larger fleet of vessels and a more elaborate system of defence. To do this would require an enormous increase of the Navy. Not only is it true as regards ships, but also in regard to the very great number of men it would require to man them—many more than are available; and if it were done, our industries might suffer from the withdrawal of skilled labor.

Let us take any four of the great commercial ports which differ hydrographically, and determine what classes of vessels, and the number in each class, are necessary to furnish each of them with the very best defence. All those vessels which are common to each of the harbors should be furnished, built and supported by the General Government, but the special vessels found necessary should be built by the States in whose waters they will act, and be manned by the militia of those States; or if built by the General Government, should still be manned by the State troops. This idea of mine will meet with objection from the very outset, especially, I am afraid, from my naval brethren; but when we remember that these special vessels will be either torpedo vessels or harbor armor-clads, we can see how easily they could be officered and manned by those who follow the water trades about their homes. The Naval Volunteers and the Volunteer Torpedo Corps of Great Britain, organized for her coast defence, will be a safeguard which the whole world will be quick to follow one of these days. The tugboat captain, who knows his waters perfectly, will, in my opinion, in this particular case of commanding harbor-defence ships, be of more value than the naval officer, and will permit this latter to serve his time more strictly at sea.

Under the common-sense rule of employing people in callings with which they are best acquainted, and thereby reaping from their work the greatest return, it would seem to be logical to employ such volunteer bodies where they are undoubtedly familiar, in vessels which they have built, and in which they have been thoroughly drilled. It must be remembered that times are changed; that wars

are a question of days and not of years, though the destruction is as great as formerly. You cannot take a recruit now and make him of value after the beginning of hostilities. His highest value would be found in keeping him in a certain station, in a certain ship, acting in a familiar locality, as I have indicated.

It was my good fortune last summer to make a short trip in a vessel, a double-screw gunboat, the Avon, officered and manned by a body of naval volunteers. There was a naval lieutenant on board, not part of the organization, but who was embarked as "guide, philosopher and friend," and who was never to assume control unless he conceived that Her Majesty's property was in danger. The commander was a merchant; one of the sea officers was a London physician of standing; one of the blue-jackets—he was peeling potatoes when I saw him—was a London barrister with a practice which brought him in $10,000 a year. There was a small leavening of sailors drawn from the Royal Navy among the crew as supernumeraries.

As far as I could see, the work was perfectly performed, the ship being taken into port and anchored in a skillful manner. The crew was finer than most of the crews of naval vessels, since a number of them were educated men, and were serving from enlightened motives. These gentlemen paid their duty to the Crown in this way for six weeks in the year. What a chance for our yachtsmen! How easily this could be done in New York! In one week two regiments could be made web-footed, and the drills could be had on board the Minnesota, or the Government could supply under proper control, as in England, men-of-war, for instance, the Wyoming, at the Naval School during the summer, or two or three monitors. These regiments, or whatever may be found to be the best designation for this force, would be uniformed as are the corresponding grades in the Navy, with some proper, distinguishing mark. This system will not only employ people in time of war on an element to which they are accustomed, but will also be of great service to us in the Navy, the least known of all the servants of the Government, as we can then have something in common with our fellow-citizens. If we can show ourselves worthy of their consideration, we shall be sure to receive it, and if we can prove our superiority in our calling, as our experience *should* enable us to do, they, of all people, will be quickest to acknowledge it, and to give us their admiration.

The system by which the tactician would determine the defence of a locality would be something like this: He would obtain from the

proper sources the distance inland from many points on the seaboard to which an invading army could penetrate without establishing a permanent base. This distance for each point would depend upon how far he could penetrate inside the coast-line before he landed, on the means afforded him to transport his supplies upon landing, and the point at which he would certainly be overcome by the armies resisting invasion. These positions being laid down on the chart, a line is sketched through them called the *inner line*. Now, every water-way lying between this line and the coast is closely scanned. It is decided how many gunboats would do for this river, whether this water could not be cut out by mines, or by a battery on shore, and whether any of the merchant steamers engaged in traffic hereabouts could be utilized for transport or combat. Next, the estuaries are gone through with in the same way: so many torpedo boats, gunboats, or light-draft armored vessels to this sound or that bay, or again, such-and-such vessels to defend this magazine or that strategical point. Then descending to the exposed harbors, the line of forts and shore defences is supplemented by an adequate number of armored and protected vessels, also by torpedo vessels, torpedo boat-hunters, corvettes and rapid-firing gunboats. The coast-line has now been reached, and light-draft lookout vessels are stationed every few miles along it. Here can be utilized small coasting steamers and revenue marine vessels. The tactician now provides for scouring the coast. A line called the *outer line* is drawn through a series of points set off normally from the coast at a distance equal to a twenty-four-hours' run for a fast cruiser. Then, to each harbor of size in the district under consideration, there is allowed a certain number, from two to eight, according to the prominence of the port, of the very best sea-going vessels which will be built for the Navy. These will be large cruisers, both protected and unprotected. They will, in well-disciplined squadrons, never less than four ships together, sweep up and down the coast inside the outer line. Here is where fleet drill of the most rigorous kind comes in, and here, too, is where naval reputations will be made or lost. Having provided for the defence, we get a list of what we want in the way of vessels; and I am free to confess that in a district which would include a great commercial centre, the number would be very great. Of course, they could not all be supplied at once, and all sorts and conditions of vessels would be needed. *The thing to do would be to build both ways from the coast-line.*

It can be seen that such a system will always work, although the

characteristic features of the vessels would change. Let us adopt this or some other *system*, and, having once done so, for pity's sake, let us stick to it. Congress, the President and the Navy, would know, from year to year, just what would have to be done, and how much would have to be appropriated, making a great saving in time, temper and talk.

Now, having arrived at a system for defence, let us follow the plan by which a foreign cruising, offensive-acting navy should be built. As we have said, this question is much more complex, but is based upon conclusions reached something in this manner: Find out towards what countries our commerce, outside of the great nations of Europe, tends; then arrange each country according to the categories deduced from the following:

First. Its political instability, since a change in its government might bring about complications with our own.

Second. Its commercial relations with this country, derived either from the amount of United States tonnage entering its ports, or the value of consignments of United States produce to American merchants within its borders.

Third. The navy required to subdue it, arrived at by determining the defensive and offensive forces, military and naval, of the country, and its hydrographical and topographical characteristics.

The product of the standings under each of the three categories for each country will give it a war value, and it is for the nation which has the greatest value that our navy should be built to deal with.

Of course, all the sea-going ships built for defence would go to reduce the amount needed for foreign offensive operations.

I well know that all this technicality is intensely stupid to the non-professional listener, but I am very anxious to show him that a navy, to be worth anything, must be built up under some system, and that such system exists, otherwise his money, in common with that which comes from the other taxpayers, will be generally thrown away.

Nor is England free from legislators and others with shipbuilding "fads." Not only in Parliament, but in technical congresses, discussions go on as to whether it is better to build one armored vessel or half a dozen torpedo vessels. The side in favor of the small fry is especially "taking," since the larger vessel costs in pounds what the others cost in shillings, or even in pence. But, somehow or other, these gentlemen seem always to forget that the torpedo boat is worth nothing but against a ship. It cannot carry troops

past batteries, it cannot fight forts, nor can it keep the sea for a long time; and if it costs less, its lifetime is out of all proportion less than that of the great ship. Whether the torpedo can do much harm to a well-bulkheaded ship, remains to be seen. Last summer's experience with the Leander, which vessel tore a great hole in its bottom with a rock, was worth more to the British Navy than the price of half a dozen Leanders, since it showed how badly wounded a vessel could be and yet survive. No torpedo, in my opinion, could have hurt her worse. If torpedo boats are to be used at sea, they must be, as they undoubtedly will, larger, stronger, and armed with rapid-firing guns. The torpedo boats which accompanied the English Particular Service force last summer were so badly used up, battered like old tin pans, leaky and slow, with the frames showing through the plating like the ribs of famished beasts, that they would have been worthless against an enemy. It may, indeed, be said in regard to such boats as these, if an enemy can keep them on the alert for six weeks without his exposing himself, that after that time they need hardly be feared. Shall I go too far if I say that the torpedo-boat outfit furnished to naval powers prior to last year may as well be labelled: "Harmless in a sea-way—unserviceable after two months' employment"?

In conclusion, I would state that the object of this paper is to show the value of these war studies, and that their investigation is our legitimate field for work. It is for such as this that we are educated at the public expense, and it is in this direction that the people expect us to excel. Having no ships, all sorts of scientific *leads* have been followed by naval officers, which speaks well for our desire to be mentally employed; but which employment is foreign to our profession, and which conspires with Congress, where it would seem that heretofore patriotism had been subordinate to party prejudice, to make us of less value as officers, and seamanship or naval tactics, whichever you may term it, a lost art.

DISCUSSION.

The Chairman:—In behalf of the gentlemen present, I beg leave to return thanks to Commander Hoff for the exceedingly interesting and suggestive paper which has just been read. I did not come prepared to take any part in the discussion, but I will express just such thoughts as occurred to me during the reading of the paper. I wish I were better prepared to take part.

I shall not find fault with the use of the word "tactician": I do not care to discuss mere terms. I think, however, that he gives a broader meaning to the word than is generally allowed by modern writers. The lecturer discusses the fundamental principles of naval administration, and the foreign and domestic policy of the National Government; that is to say, he provides for defences—maritime defences, not those on land, but those to supplement the land defences—to be supplied by the floating force, and the question now comes up as to what we are to provide against; what countries are we to expect an attack from? Obviously, there is no object in making any very great preparation for an attack from Switzerland. But what countries are there that we may, in the course of a long experience, expect an attack from, and where will they first strike? What will be their first hostile movement? I think by reasoning in that way we may come down to the force required. From our experience with England, we know that she had two plans of attacking this country—one, a campaign by way of the Lakes; and another by way of our harbors on the Atlantic coast. They once took possession of the waters of the Chesapeake, and we were perfectly powerless to eject them. Reasoning in this way, we may take up the different maritime countries who would undertake to land a force on this coast; but, to cover the entire field of inquiry, it seems to be desirable that the naval administration or the persons who are to act in that capacity should provide against all possible contingencies. So you come in turn to England, France, Germany, Spain, and the rest of them, and say, in case of a conflict with each and any of them, just what is to be done.

The next step would be to divide our coasts into different maritime districts —*arrondissements*—like the French; the Lake frontier, the middle, the Gulf, and the Pacific. It is almost impossible for Spain, in the event of a war, to make any demonstration on our Pacific coast; nor would she be likely to do so on our Eastern coast; so that you narrow the question down to almost one certain locality where a hostile demonstration would be made, and there you are to make your preparation.

I merely offer these few remarks to open the discussion. Now, the thing is to provide against any power having a lodgment in our inland waters—in Long Island Sound, Chesapeake Bay, and Narragansett Bay. A foreign squadron establishing itself in any one of these ports would be very destructive to us. The only thing to do is to supplement our land defences by a floating force. Fortunately, we have here this evening a member of the Fortifications Board, and I would be glad to have him throw some light on this interesting subject.

I believe, myself, that the system of maritime coast defences that we have already inaugurated by means of the monitors is one of the best. The monitor has the advantage of light draught, a necessity imposed by the shallowness of our coasts and harbors, carrying the maximum amount of offensive force with the minimum amount of tonnage.

One of the next questions would be the number of seamen we could muster, counting all the available seamen in this country; to see how many vessels we could properly man. As to that part of the essayist's remarks which call for a volunteer force, I do not believe, in this country, it will be practicable, if desirable. Your barrister friend peeling potatoes, I do not believe is possible in this country. They have tried, and only succeeded in getting volunteers to go down to Fort Hamilton to practise with the artillery. I do not think the people will do it. They will go out and parade in uniform with the young ladies looking at them, because there is something very spirited in that: it is very pleasant. But to go down the seacoast to work those heavy guns—it does not show up well. And you will find very few of them who will be willing to go on board ship, unless the danger is so imminent as to drive them to do it. But I say I think we can bring it down to a fixed point, that we could reason, in the way I have mentioned, the probable enemy we might have, fix upon the enemy, and where he would make his first attack. That is the question; having settled that question, what force must we have to meet him? We must not only have force to meet him, but to crush him. We can be studying out these questions coolly beforehand. So many men and so many guns must be at such a point at such a time. That is one of the problems to solve.

I do not care about terms. I do not think the providing of defences belongs to the tactician. It belongs to the Navy Administrator to administer the affairs of the naval government. An officer said to me to-night that he had never been in the Navy Department, meaning to say that he had not been concerned in its affairs. Nor have I, and I am not prepared to say what is going on in the Navy Department; but, so far as my knowledge goes, I do not know of a single officer who has the duty assigned to him of saying what shall be the first movement of this country on the waters in the event of hostilities. If there is such an officer and such an office, I do not know it, that is all. And when during the *fiasco* created by the Virginius, I know perfectly well that somebody was, so to speak, "at sea," and it would have been better if they had been so literally, instead of figuratively. They did not know what to do, and somebody did then a most disgraceful thing in sinking a coal barge at the head of the dry dock to shut in a possible enemy's ironclad. If that was not an evidence of the weakness of this country as a naval power, nothing was. This country should have said, "Here, we will hurry you through and let you go to sea and meet any power that Spain can put upon the ocean!"

I beg your pardon for my rambling remarks; I should be glad to hear any gentleman on the subject of the paper.

Rear-Admiral SIMPSON, PRESIDENT OF THE INSTITUTE:—To undertake to deal with what we have listened to, properly and elaborately, would require more time than we are likely to give to the matter here. The paper is suggestive, but there is one point to which I wish to address myself, which is denomi-

nated Tactical Science, which, as defined by Commander Hoff, is a subject that we should all accustom our minds to.

I am inclined to think, however, that the tone of his address would lead one to suppose that this tactical science, so-called, has been heretofore entirely neglected. I allude to it as applicable to single ships, and not from the more general and administrative point of view brought into consideration by the remarks of the Chairman—I mean the study of combining in one ship the features particularly required by her for the specific duty for which she may be assigned; that, I understand, is the tactical science, so-called, as applied to a ship.

Now, that is a matter that, in our new ships, has been very deliberately thought out, and the great study in designing and planning their general features has been this very point. The understanding seems to be accepted by the country and by Congress that different classes of ships are required for special duties differing in their character; that as these duties differ, so must the characteristics of the ships differ, and this study, called by the speaker tactical science, is being carried on now by those who have charge of the work on these vessels. For example, an unarmored cruiser that is intended to keep the sea for a long time must have a large coal endurance and high speed; she must yield in her gun power, and she has no protection except that derived from her system of construction; she has no armor. The coast-defence vessel must be as strong as possible in offence and defence, her speed must be reduced and her coal endurance limited, and the space for all consumable articles must be diminished as much as possible; that, I understand, comes under the head of tactical science as the term is used by the speaker.

Now, the classes of vessels proposed by Commander Hoff seem to be all very much provided for by the propositions already advanced; the unarmored cruisers and armored cruisers are being built, and are under consideration, and the Fortifications Board has given us designs in accordance with this tactical science for vessels for the defence of the coast, and for that of interior waters; thus, it seems that the call for suitable vessels for specific purposes is pretty well answered now in theory; it remains only to embody these ideas in practical form, which will demonstrate that this science has been called into service. The torpedo boats that have been recommended are available for all purposes of inland work alluded to by Commander Hoff, so I think that most of his suggestions are being now acted upon.

My remarks are intended to express my opinion that we should not be accused of having neglected this science up to this time. I think, rather, that we have adopted it.

Commander HOFF:—The remarks of Admiral Simpson call me to a sense that perhaps my remarks might be construed in that way. I did not so intend. As to what has been done in the way of building our new vessels, I think that the mere fact that the good which has been done in this direction is what attracted my attention to the fact that if the whole Navy would wake up to appreciate what those who are building our vessels are doing, it might tend to hold up the hands of those who are rehabilitating our Navy in a way, to say the least, that is making great strides in the proper direction. I think that if

the whole Navy were alive to the importance of the work, and would send in the results of their study and observation, the Board which is building our vessels would be greatly assisted thereby. From the time the first vessel was laid down under the last Board (I mean the vessels which they are now finishing), I think the members will say, as they went along step by step, they were obliged to learn, as well as put in practice, what they already knew.

Now, in regard to these new vessels, it seems to me that it would be well to install some smaller guns by the substitution of V.- for VI.-inch guns.

I think all these points in the study of tactical science show how much there is to it; and as for the officers who have devoted so much time and labor delving into the science of modern shipbuilding, and have given us the first modern thing that we can call our own, I am certain the greatest credit is due; and as to assembling the factors of war in what I call a tactical, scientific way, I consider myself to be only a novice.

The Chairman:—Yes, that is it; one set of men giving entire attention and study to one branch, and another set of men to the study of another. It is not every set of officers that can devote their time and attention to every study: it must be divided among them all. It is by bringing together the work of many that we achieve great results; each man working in the line of his own specialty.

Commodore SCHLEY:—The paper of Commander Hoff is extremely interesting and suggestive. As a plea for more earnest study of the policy of defensive protection, it commends itself to my judgment as an excellent outline of the direction into which our attention should tend. In case of defence, the plan of districting the country as indicated by Admiral Luce would unquestionably be resorted to; that district to be most carefully guarded as its commercial interests would invite attack. Commander Hoff has indicated a type of ships and a system of attack and defence that would embrace many peculiar vessels.

It has been stated by eminent authority that the fighting officer is best qualified to know what type of vessels are most needed for offensive and defensive purposes in war, and that the most successful constructing officer is he who can so mould his ship and accommodate her to the conditions set forth by the fighting officer as necessary.

In this view, therefore, there is unlimited scope for the mentally active and progressive of our service. Papers of the character under discussion must tend to certain good results if looked at in the right spirit, or if discussed with the sober desire to add to our information all that most concerns the public protection.

The time has passed when we could improvise our defence from the declaration of war until the arrival of hostile fleets upon our coasts. The vaunted ocean barrier of former days has been annihilated by the swift machines of to-day, so that future wars between nations will be almost as that between man and man: the insult will be followed by the blow. Our special province, then, is best fulfilled by giving our most earnest study and thought to the considera-

tion of just such things as Commander Hoff has so admirably presented to-night. I think it would be safe to say that if we as a body will give ourselves more to this intricate concern of war, and to all that may be needed to make it most destructive to our country's enemies, our advice and opinions will gain respect everywhere. We shall at least be better equipped when the time shall come to improvise hastily the defence of ports, or of coasts, than if we waited for the emergency before deciding what was most needed.

One point of this excellent paper deserves attention, if not criticism; I mean where Commander Hoff speaks of the special vessels that are found necessary in his system, and his declaration that these should be built by the States and manned by its watermen. It must be admitted that all naval vessels to-day are to a greater extent machines than ever before. Our profession has grown to one in which nobody not an expert could have any place. The various implements used on board ships of war all require most careful training to their uses: our delicate machine guns; our intricate torpedo fittings; our wonderful search lights; our elaborate electric-lighting connections; our new and expensive guns, with the masses of delicate machinery for working them,—all would seem to favor the idea of special training. It certainly combats the notion that men could be picked up about our seaports who could acquire this necessary knowledge of these new things in a few days. It certainly argues for permanent establishments, rather than for those thus irregularly maintained as Commander Hoff's paper suggests. As the scope widens, and as so many of the newer sciences are applied as destructive agencies in the work of the new war ship, there appears to me less and less chance of usefulness for the man who is not trained to the service requirements. The same need which is so apparent for the officer is in like degree required for the man of our Navy.

This view of that part of his paper would appear to throw out some objection to Commander Hoff's idea. Perhaps he will agree with me that those States which maintain no skillfully trained officers, could hardly be expected to depend upon their tugboat captains for defence against the offensive fighting power of such machines as would be brought against us. Right here I would say that the multiplication of machine guns on naval war ships makes it certain that the destruction of life will be greater than ever before. This emphasizes the need that all officers of war ships should be eligible to command. This would lead to similar education and to the obliteration of the present corps system of navies.

If we could organize in this country such a system of volunteer organization for coast defence as England has, there would be no doubt of its utility in time of war. But there is this in the way: here every one looks upon the military power and upon military service with some dread; and upon peace as in some way an assured thing. The public defence is looked upon as a thing that will take care of itself, or, at all events, when it is forced upon the public attention, means will be adopted to secure it. In England this is different: people there are impressed, first, with the national greatness, and second, with the national safety. There yet live among the English people the inherited traditions of invasion and what they meant in the olden time. It is these things which make possible those things which we cannot dream of here.

I thank the gentlemen of the Institute for the opportunity to discuss Commander Hoff's very instructive and interesting paper upon so interesting a matter as the policy of our public defence.

Commander GOODRICH:—There is one point in the remarks of the Chairman which I think should be corrected, for the credit of the volunteer force at Fort Hamilton. I have heard that the reason why the exercises at Fort Hamilton were not carried out to a greater extent was because they did not receive proper encouragement from the Bureau having charge of the matter at the War Department; but that the militia from New York themselves would have been very glad to continue them. For this reason, I do not think the plan of getting up a volunteer organization so hopeless as has been suggested. I am, however, not prepared to accept the lecturer's idea without modification.

There is another thing which indicates to my mind that, in any plan or scheme by which the Navy will be rehabilitated, Commander Hoff is right in insisting that the most important thing is to lay down a plan and then to follow it. We know the position which the French occupy to-day. The French Navy in its present state is certainly a very good second, if not coming in for the first place among the navies of the world, because the French laid down a plan in 1872, and have followed it faithfully ever since.

I think that Commander Hoff will call for too many vessels by his scheme. I shall be glad if we succeed in getting them all; but if we can get a few vessels to cover the most important of our harbors, and particularly Long Island Sound, the Chesapeake, and Gardner's Bay, we shall do well. I say, without hesitation, that in my opinion Gardner's Bay, in case of a foreign invasion, would be the weakest position for us and the strongest for our antagonist. I think Gardner's Bay should be occupied with a navy immediately on the outbreak of hostilities, and also, of course, the mouth of the Chesapeake, because we have already suffered on several occasions by the presence of hostile vessels on those waters. I think in protecting the principal commercial points, Chesapeake Bay and Long Island Sound, we will have done as much as we can well expect with the money we shall have at our disposal; even that will give us a comparatively small navy for coast defence.

But granted that we shall have the individual vessels going to make up a fleet, it seems that we are very lacking in exactly this study which Commander Hoff has pointed out as being so valuable. If war were to break out to-morrow with any European power, I do not know whether there is any person in the Navy Department who could say at once what is the proper thing to be done.

It seems as though we should have to take up that subject with great care, and make up our minds what to do with the means at our disposal, so that we should know immediately, without doing a great deal of thinking, just what to do at the very first approach of trouble. And, in general terms, I think that while we may not all of us agree with Commander Hoff's solution of the matter, we cannot help feeling that he has laid great stress upon a want in the service which is becoming felt; and if the suggestions he has made are carried out, not necessarily to the letter, but in the spirit, the service will be greatly benefited.

Assistant Naval Constructor BOWLES:—In considering this paper, my mind at once directs itself to the things that I meet with in actual work, and so far I have felt very much the lack of fixed principles to follow in assembling the various parts of the ship into one design.

There is one canon, as it is called in this paper, concerning which I should like to ask the lecturer a few questions. It is, that "the defence should equal the offence as nearly as possible"; and I should like to ask the lecturer if he is aware that if they were carried out, it would rule out every modern protected cruiser that has been or is being built? And that if it be true, it must be that a most outrageous fault is committed in placing the X-inch guns on the Esmeralda or any of Armstrong's last cruisers? In fact, it would reduce the armament of the Chicago to Gatling guns. I should like to ask if, in connection with the facts from which this canon is deduced, due weight has been assigned to the mine power of projectiles, or if the penetrative power only has been considered? Another canon is, that "the thinner the protection, the more separated the guns composing the battery must be." I should like very much to elicit from the lecturer a definite example of what is meant.

And with regard to the use of the torpedo boats and their value in the service. It seems to me that the importance of the experience derived from the manœuvres of the English fleet has been exaggerated, and that the reports, as far as we have them, show that the French are much more skillful in the use of torpedo boats than the English, and regard them as of the highest importance, and that in experience the torpedo boat has proved exceedingly satisfactory.

Commander HOFF:—With regard to the discussion of the first canon, that the offence and defence should be as near alike as possible, it perhaps would best be shown in this way: The broadside battery of the Chicago is the same nearly as the broadside battery of the Renown—that is to say, it is composed of VI-inch guns. Well, if it is not the same, take two vessels—take a large Chicago, with eight VI-inch guns on a side, and take the Renown, which has about that number; you would think that one VI-inch gun should be equal to another VI-inch gun. But one battery would be protected by a side which is easily penetrated by rapid-firing guns, while the other is protected by a side which is not penetrable to rapid-firing guns. In my opinion, the other vessel, the Renown, say, would fulfil more nearly the thing to be striven for than would the Chicago. You cannot do any better than thin sides sometimes, because there are a thousand and one questions modifying the thickness of the ship's side; and, therefore, I only say that the Chicago's side is not as good as the Renown's side. The one has a VI-inch gun installed better than the other. However, there may be sufficient good points in this ship to afford the violation of this canon. A change from VI-inch to V-inch in the Boston would give us the disposition of armor to resist secondary fire, represented by steel plate one and a half inches thick, six feet by one hundred feet. In my opinion, the change should be made at once.

In regard to the canon, the thinner the sides are, the more separated the battery would be; we cannot always rely on one vessel always fighting one

other vessel, and it must be remembered that gun shields only protect in the direction in which the guns are pointed. Take a vessel where all the guns are in the same compartment, as in the Boston or Atlanta: there is no separating one gun's crew from another. They are a mass of human beings kept in a box just thick enough for rapid-firing guns to kill them all. If some of those guns had been aft and some forward, then there would be two *nuclei* instead of one unit. The enemy's secondary firing would then have to be distributed over a greater space, and the slaughter would be less severe in consequence. A rapid-firing gun which is churning out projectiles would be less likely to kill where its fire is divided between two points. Now, the canon goes a great deal further. I have, say, two V-inch guns, which I am endeavoring to overcome an enemy's vessel with. If I can put one V-inch gun in one ship and one in another, and make these two vessels keep a certain distance apart, and manoeuvre together, I could do a great deal better than if the guns were together in the same ship, since I break up in the greatest degree the force of the adversary's fire.

Now, in regard to torpedo boats, I can only say, from what I saw of those which returned from the Particular Service Squadron last summer, in England, and that I went through, that all of them were battered and shaken up. In some the engines looked as if they had been up the hatch and back again. I should think that none of them could make more than nine or ten knots an hour. The French have not had the same experience; I cannot compare one with the other simply because the conditions by which I judge one service are not applicable to the other.

I was told by a Russian navy officer, Aide-de-Camp to the Minister of Marine, that in Russia they keep a record of their boats to determine which are the best, as they have been very large buyers of them in all European markets. And it was determined that the English boats are not so well built, and compared in no way, he said, with the French boats, and that the French boats were very much superior in the question of maintaining steam pressure, and as regards the performance and economy of their engines and their stability at sea. It is but fair to say, however, that relations between Russia and Great Britain were very much strained at the time of this conversation.

Assistant Naval Constructor BOWLES:—Mr. Chairman, the lecturer has brought out exactly the point I wished to make—namely, that the opinions expressed in regard to the English torpedo boats should be as to faults in their design or construction, and should not approach a condemnation of the value of torpedo boats in general, which is the impression I derived from the lecture.

Admiral SIMPSON:—I move, Mr. Chairman, that the thanks of the meeting be extended to the essayist for his extremely valuable and interesting paper.

The motion was carried, and the meeting then adjourned *sine die*.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MARCH 17, 1886.

COMMANDER P. F. HARRINGTON, U. S. N., in the Chair.

BATTLE TACTICS: THE VALUE OF CONCENTRATION.

BY COMMANDER H. C. TAYLOR, U. S. N.

In presenting some views concerning the principles of naval tactics, it may be well to say beforehand that these views are in some respects contrary to the general sentiment of naval officers. Some accepted axioms—such as the great importance and value of large ships, large guns, armor, high speeds—are in some measure dissented from; and the ideas generally are not in line with what is known as modern naval thought, as exampled in the development of the present European navies. I am glad to place these views before the Naval Institute, a body so intelligent and so capable of deciding how far these opinions depart from approved custom, and to what extent they should be considered revolutionary or injurious.

The methods I suggest, however, are meant to lead to a most conservative end, concentration; and in making that principle my text and urging its importance, I am only stepping humbly in the footprints of the centuries. Cæsar and Napoleon, Themistocles and Nelson, have recognized it as the essence of victory; have known how so to manage the details of their organizations, the qualities of their individual ships or regiments, the energies of their lieutenants, as to obtain that concentration, so difficult to reach, yet, once attained, so fruitful in victories. Nor does any one of the present age deny in words the value of concentration—assuredly not any naval officers of the present education and experience—but many of us, impressed by the wonderful advance of ingenious mechanisms in these later years, and separated by so long a period from the example of great naval wars, have allowed many minor questions to come between our thoughts and the greater principles of warfare. Concentration has been at times advocated. Solid squares, groups, triangles, have been suggested—for the most part casually, however, and as a minor detail—and at one time, in an able paper by Lieutenant Mason, read before

this Institute in 1876, concentration was effectively urged, and the use recommended of hollow squares with reserves inside, a formation approaching closely the compact orders described in this paper. Such efforts, such suggestions, have been rare, however, and have provoked but a faint attention among modern navies, as of something important and true, but as not specially affecting them; and thus we continue to prepare war ships to be powerful singly, but with little reference to their availability as units of a great and effective mass.

Nelson knew he must concentrate to win; but how was he *able* to concentrate with such brilliant success? Principally because the English builders had built good ships for their navy, similar ships, ships whose build contemplated, first of all, working together, close together—because the Howes and St. Vincents, who came before him, had, through much hard work, trained those ships to work in fleets close together. Thus, when the master mind appeared, grasping the soul of a warlike crisis and commanding effective concentration, the response was instant. Nor were the master's energies wearied and his genius wasted in the long and tedious preparation of ill-assorted fleets and untrained men and officers. We may not all be Howes and St. Vincents, but we may all do our part toward preparing our fleet for that day of our country's need when a Farragut or a Nelson shall demand that trained activity and readiness in ships and crews which is needed for concentration and resulting victory.

What, then, is the object of my paper? Not to prove that concentration is important. That fact is fully recognized, though little acted upon. My object is to urge that it be not only casually acknowledged, but that in every detail of our naval preparation it be kept in view as of prime and critical importance. And I will be doing my small part if I emphasize in this paper the value of concentration in tactics, in the actual engagement; leaving aside for the present the strategic combinations of long-continued operations afloat or ashore. It is concentration in the battle, therefore, rather than in the campaign, which I shall now consider.

What method of tactics will best lend itself to effective concentration—to the massing of our fleet upon a portion of the enemy's fleet? In approaching this question, we must consider what formation will be brought against us. The battle-ships of European navies to-day are of such a character as to make it probable that their formation for attack or defence will be the reverse of a close or solid forma-

tion, that it will be an elongated line, single or double, or a number of detached groups in line or echelon. To approach such a line with our own vessels compactly massed and retaining that compactness during preliminary manœuvring, would ensure the ability of striking the enemy—after preliminary feints—at such portion of his formation as might seem expedient. If we add to this the ability to disengage our ships from this close group and to deploy them, when closing with the enemy, it would seem that we have attained the principal conditions essential to success. Such formation should be of the most simple character. The confusion of battle and the many difficulties of wind and sea make simplicity imperative. For the same reasons, this formation should, through constant use, be familiarly known to the fleet, an order in which they would quickly and naturally gather in a time of confusion or when signals are obscured.

The plan I have to suggest for consideration is the massing of the fleet or squadron in a solid square, or as nearly that as the number of vessels may permit—four ships forming a solid square with a side of two ships (Fig. 1); the solid square of nine ships having a side of three ships (Fig. 2); of sixteen, a side of four (Fig. 3),

Fig. 1. Square of Four.

Fig. 2. Square of Nine, one inside.

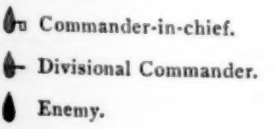


Fig. 3. Square of Sixteen, four inside.

and going on to larger squares, if desirable. The solid square of four ships would have all its ships outside; that of nine would have eight outside; of sixteen, twelve outside, while it may be observed that the number of inside ships in any square equals the whole number of ships in a square whose side numbers two less ships than the side of the square considered. Before discussing some of the features of this formation, it will be well to say that it is the value of concentration in general that I wish to urge, and not this particular form of concentration. The solid and the hollow squares, as two forms of the "naval square," have been occasionally discussed, and the latest authority on the subject, Commander Bainbridge-Hoff, assigns the name of "naval square" to the solid square alone. Many forms of attaining concentration have been at different times suggested. At present, I believe the solid square (or naval square closed in mass) to be the order which, with our improved modes of propulsion and steering, offers the greatest manoeuvring effectiveness, and I shall use it as a text from which to preach the value of close formations and the importance of incessant sea drilling to make such tactics possible. The natural divisions of a fleet in such an order would be the columns which when closed in mass form the square, or the lines which divide the square at right angles to the columns. The flagships of the Admiral and his Commodores should be on a diagonal of the square, in order that whichever way the Admiral shall divide his fleet, each division may always have a divisional commander.

The fleet being in *column of divisions in close order*, the Admiral would simply signal the divisions to *close in mass* (Fig. 4), and the

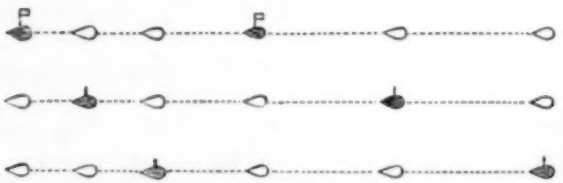


Fig. 4. "Fleet close in mass"—"Van division slow."

closing would continue until distances ahead and astern were equal to distances abreast.

The fleet being in *columns of vessels abreast by divisions in close order*, the Admiral would signal the divisions to *close in mass* by

Fig. 5. "Fleet close in mass"—"Centre div. slow"—"Van and rear oblique."

obliquing upon a designated division (Fig. 5), and the closing would continue until distances abreast should be equal to distances ahead and astern.

The fleet in *column of vessels*, van division leading, the Admiral may signal the fleet to *form in mass upon the van division* (Fig. 6), that division slowing to steerage-way, and the remaining divisions obliquing into position at full speed; or he may designate the second division for

Fig. 6. "Fleet close in mass"—"Van division slow"—"Centre and rear left oblique."

Fig. 7. "Fleet close in mass"—"Centre slow"—"Van to right rear"—"Rear left oblique."

the fleet to close upon, that division slowing, the vessels of van division turning together and obliquing to the rear, and the remaining divisions obliquing at full speed into position (Fig. 7); or if an enemy is discovered ahead and close aboard, the rear division may be designated, and the remainder of fleet, turning together (Fig. 8), will oblique at full speed to the rear into position. Similar principles would govern the fleet when in line, the division designated slowing or keeping full

Fig. 8. "Fleet close in mass"—"Rear slow"—"Van and centre to right rear."

speed, according to its position in the square, and the remainder of the fleet moving into position in front or rear of it. It must be thoroughly understood by the fleet that the relative positions of the divisions and of the vessels will always be the same in the solid square, in order that they may drop readily into accustomed positions made familiar to them from long habit; and they must in time of war cruise almost constantly in this order, by day and by night, in good and bad weather, so that when expecting to meet an enemy they may keep in that order and avoid the possible delay of gathering into the square formation from a long and perhaps scattered column line or echelon.

In forming the square, therefore, after thorough drilling of the fleet, the Admiral, in addition to the simple signal to "*Form Square on Division designated*," would only need to give the compass signals to indicate the bearings of the lines of the square. The compass directions of the diagonal line of flagships and of the divisional lines will be sufficient, the diagonal's direction being made the principal indication in the signal. The signal, "*On Van Division Form Square, NE. Division Lines East*" (Fig. 9), will inform the fleet that the Admiral's flag is to bear northeast from the divisional commander's, and that the lines of the divisions will be east and west. The signal, "*On Van Division Form Square, NE., Division Lines North*" (Fig. 10), would inform the fleet that the Admiral's flag is to bear NE. from the divi-

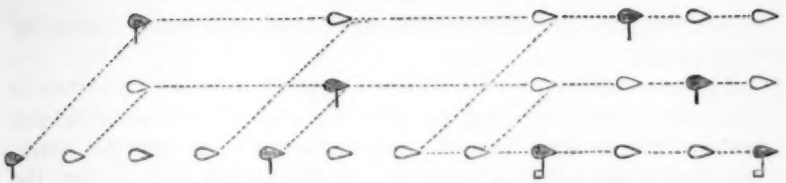


Fig. 9. "On van division form square NE"—"Division Lines East"—Centre and rear "Forward into line left oblique."

Van Commodore signals —"Forward into line left oblique" then "Slow."

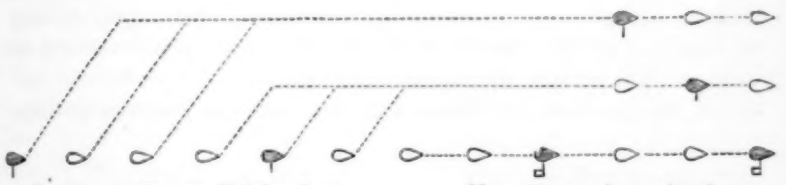


Fig. 10. "On van division form square NE"—"Division lines North."

Van Commodore signals—"Slow": Centre and Rear Commodores—"NW" then "North."

sional flags, and the lines of divisions will be north and south. It will be needless further to describe methods of forming the square: the simple principles of tactics will apply in all cases, with but slight modifications, both in forming square and in returning from it to other orders of steaming; but I will repeat that when expecting to meet an enemy, the fleet should keep in this compact order day and night.

No manœuvring is contemplated while in the "square" formation, except changes of course, and those are to be only the simultaneous change of direction of each vessel of the fleet. There will be no turning of head of column after the signal to "form square" is executed: the only signals will be "*Fleet SW.*, 10 *knots*," "*Fleet ENE.*, 5 *knots*" and similar signals to indicate direction and speed. Even these simple changes of course, you will say, will be difficult for vessels massed in such close order and moving at high speed—nor do I question the difficulty. Ships of great handiness and exactly alike must be built to ensure a homogeneous fleet, and officers and men must be drilled to the last point to make it possible—and even then it will be difficult; but I do not doubt that victory will be with that navy which meets and overcomes such difficulties, and which, by providing this or some similar battle formation for its fleet, shall

ensure the great principle of concentration of force being thoroughly worked out.

I propose, as before said, that the fleet shall habitually remain in this order when expecting to sight the enemy; that once sighted, whether the enemy advances, or remains quiet awaiting the attack, our fleet *shall advance upon it.* If the enemy were in line, the solid square would direct itself, perhaps, toward its centre, steering south, we will say. Approaching closer, the Admiral may signal, "*Fleet SE.*" (Fig. 11), when each ship of the square, consisting probably of nine or sixteen ships, changes course simultaneously to SE., without change in order or bearing—somewhat (if thoroughly drilled) as a school of fish, moved by some common impulse, swerves to right or left without derangement or disorder. Approaching still closer, the enemy's fire becoming hot, and his reserves perhaps

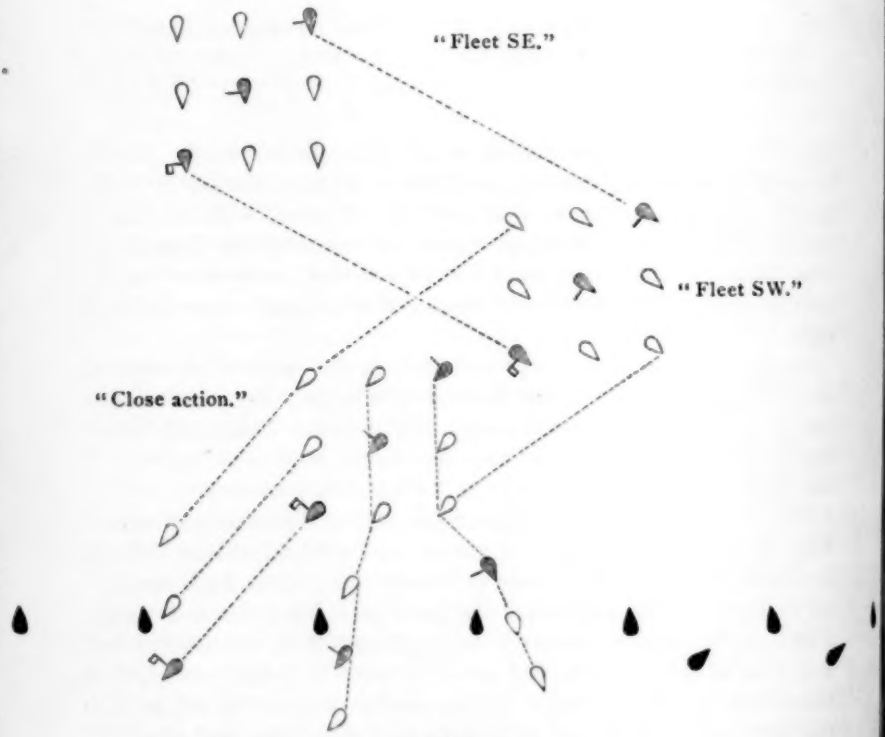


FIG. 11.

hastening to reinforce the threatened eastern division, the Admiral may signal, "*Fleet SW.*," and strike, finally, the enemy's western division. As he closes with the enemy, some deployment becomes necessary, and is simple in execution. The Admiral may signal his eastern division, "*Division South*," the centre division or divisions "*Division SSW.*," and the western division "*Division SW.*" This divergence, or a greater, if desired, will cause the divisions to reach the enemy's line with space enough for their effective fighting.

It is, however, probable that the details of such deployment would be governed by a permanent arrangement, preconcerted between the chief and his subordinates, the proper moment for deployment or separation of divisions being indicated by the flagship's signal to "*close with the enemy.*" The Admiral would also, at this time or before, inform his Commodores, by a simple signal agreed upon beforehand, whether he intended them to bring their divisions alongside of the enemy and fight it out, or whether, preserving their divisional close order, they should pierce and pass through the enemy's line and reform to some extent on the other side. In this latter case, the simplicity of this formation and the fleet's entire familiarity with it become most valuable. Upon emerging from the smoke on the other side, the vessels—such as got through—would gather quickly into their accustomed battle order, ready at the Admiral's signal to return to their original point of attack, or, if his judgment should so decide, to throw themselves upon some other point of the line.

I think this second formation is not likely to occur, though possible. The old style of delivering broadsides and passing on would permit it, but the ramming inevitable in present fleet fighting must cause delays and confusion. Thus, though many advantages would come to the fleet capable of piercing an enemy's line and reforming instantly on the other side, it should not occupy our minds too largely; nor should any plan occupy us seriously which treats of signals, alignment, formations, *after* close battle is joined; once in hot action, it is not likely that tactics will much avail: bravery and skill and the nautical habit, with a fixed resolve not to surrender, will principally decide the day, when hostile ships once get alongside of each other.

If the enemy is in column heading toward you, which is unlikely, except, perhaps, if surprised by sudden fog-lifting, the square falls at once upon the head of the column, two divisions (say six ships) doubling upon three or four of the enemy's leading vessels, while

the third division, passing farther down the column, takes up the work of delaying the approach of the enemy's centre and rear ships, advancing to assist their van division (Fig. 12). Similar tactics would

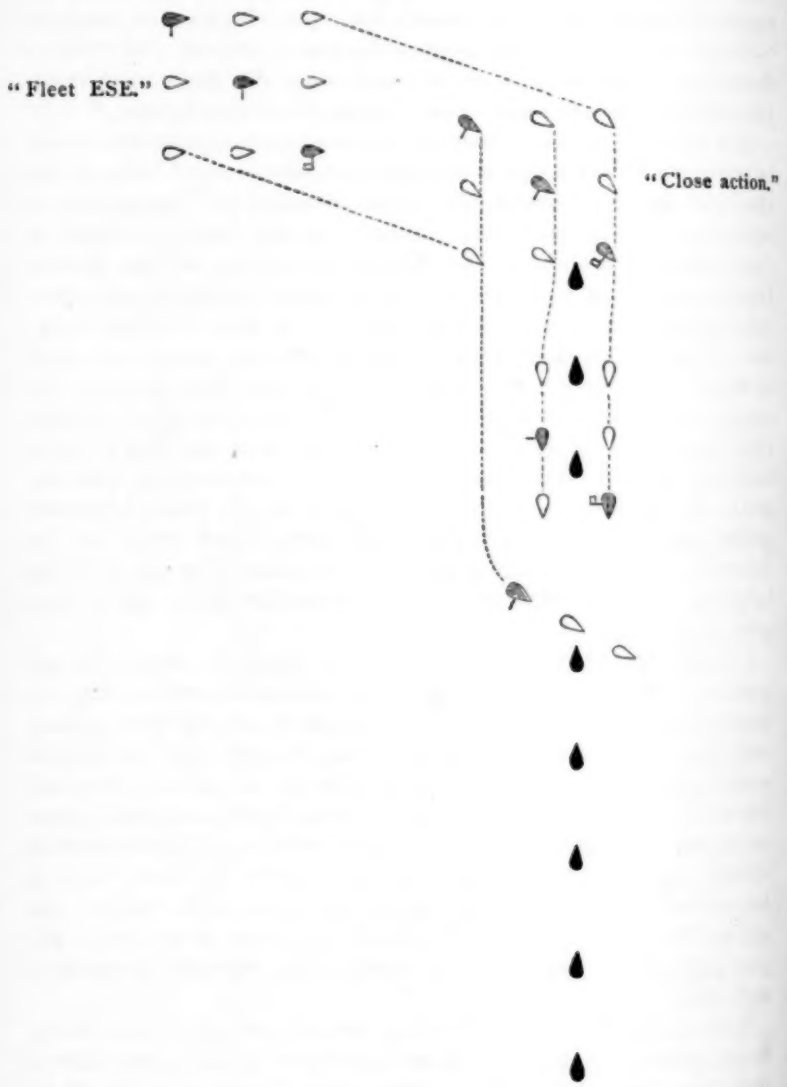


FIG. 12.

rule if the rear of the enemy's column were the nearer; while, if discovered in any detached or scattering order, our compact formation would show its greatest effectiveness.

An advantage of this "square" order, and of providing for its remaining unchanged, is that preconcerted plans can be made with some assurance that they will not be interrupted by the many accidents possible in actual practice. An Admiral, assured by incessant drills that his fleet can maintain this order, may clearly indicate to his officers his probable method of giving battle. He may thus say beforehand: "When, after possible changes of course to deceive the enemy, we finally strike his line of battle, which will in all cases be indicated by my signalling 'close action' to the fleet, the two divisions nearest to that wing of the enemy which we have struck will fight that wing, without further orders. The remaining division, without further orders, will engage nearer the centre of the enemy's line, and will delay—at the cost of all its ships if necessary—the approach of the other wing. Should we happen upon the van or rear of the enemy in column, the same movements will be executed at the final signal for 'close action.' The two divisions happening to be nearer the enemy as we approach will fight the enemy's extreme vessels, and the remaining division, passing rapidly along their line or column, will throw itself in the way of their centre and other wing."

I recur again to the fact that the solid square of four ships has no inner ship whose fire is lost; that the square of nine ships has only one; that of sixteen has four; of twenty-five, nine; of thirty-six, sixteen; of forty-nine, twenty-five. In other words, over one-half the total number are inside ships in a square of forty-nine, while the sixteen-ship square has but one-quarter inside, and nine ships have but one-ninth of their total number inside. These figures are significant, and indicate that our squares must not be too large; for with the loss of fire come other disadvantages, such as the confusion possible in a large mass from the disabling of one or more inside ships. As well as one may judge without that actual practice so lamentably wanting in our service to-day, twenty-five ships will be the greatest number we can place in this close formation, and much skill in handling will be needed even for this. It might be found expedient to divide such a fleet into two squares of sixteen and nine, separated by a convenient distance for support of each other.

The solid square is for offensive purpose only. I am far from claiming for it any defensive value. It is by no means a forma-

tion in which to await an enemy's approach or attack. The evils of closely massing vessels for defence are clearly shown in the case of that fleet, in the galley period, whose Admiral, perhaps lost in admiration of the Grecian phalanx on shore, closed his vessels in a compact mass to receive an attack of a hostile fleet. The enemy encircling the group and approaching closer as they steered around it, pressed back the outer galleys and so crowded the already compact mass as to cause collisions and loss of oars among them, and finally produced such confusion inside the group that the fight was lost before the attacking fleet had made its first charge. But here let me draw your attention to the significant fact of how rarely *any defensive* formation has been successful—how almost invariably victory lies with the attacking fleet. Whether at Trafalgar, where the enemy under way received the English in a half-moon line of battle, concentrating a withering fire upon the heads of Nelson's advancing columns; whether, as at Aboukir, the fleet at anchor, sheltered by shoals, its wings protected by land batteries, received the English, approaching in single column, and obliged to thread their way with tedious caution through a dangerous channel, while exposed to the fire of land batteries and of the broadsides of the fleet—whether there or elsewhere, no matter how certain the precautions of defence appeared to be, the resolute attack has, with few exceptions, overwhelmed the fleet acting on the defensive. I would say, therefore, that I can imagine no plan so effectual for defence as an active offence, and for that offence or attack I know of nothing better than the solid square.

A fair objection to this order is that the inner ships cannot deliver an efficient fire upon the enemy, as they are hemmed in by those outside. This defect is less than it appears, for the order is to be maintained only until close action is joined, when deployment follows, and the columns of the square diverge, and each ship takes room for fighting.

Another and more forcible objection can be made—namely, that the fleet massed thus closely offers a large target to the enemy's guns when within even a long range. I do not see that this defect can be remedied. No formation is perfect. Boldness of attack indicates risks to be run: where no danger is, no boldness can be. It is well, however, to note it as a valid objection, while at the same time we may expect its effects to be much lessened by the wild firing of the best trained gunners in a seaway. The guns also which we may

expect to encounter are of great size and few in number. It required at Alexandria from fifteen to twenty minutes for each fire of the larger guns of the English fleet, and circumstances were there eminently favorable—smooth water, choice of position, a trained and gallant *personnel*, and a feeble enemy. Substitute for these conditions a fresh breeze and rough sea, an ordinary line of battle, a compact fleet threatening under swift headway first one and then another point of their line. Under such circumstances as these, we may, perhaps, justly reduce our estimate of probable damage done by the guns of a European fleet in the manœuvring preliminary to closing. And here permit me to record my settled conviction that closing must take place—that great naval battles will never be decided at long range. Single ships may fight at long range; light skirmish vessels may exchange shots at a distance; but a great battle of fleets, such a one as decides great wars, must, in the nature of things, end in close action. Whichever fleet shall find itself worsted at long range *must* close, or its Admiral forgets why he was sent afloat; and if he closes, his opponent must accept close battle or—run away. Officers of great intelligence have stated to me, as a practicable scheme, that a fleet possessing greater speed and greater gun range than an enemy might steam away from it, and, by making a running fight of it, in time destroy or cripple the pursuer. Truly, this is a pleasing picture. Gentlemen who know the sea can figure for themselves the amount of damage which the stern guns of a fleet in a seaway would probably inflict upon an enemy's fleet, miles away, and in hot pursuit. One of the runaways gets a hot journal, perhaps, and before signals can be made and read is overtaken by the concentrated fire of the enemy rapidly advancing. And if no such accident happens, what is it that the pursued Admiral is doing? He is being chased from some station presumably of importance, and which he has been sent to hold, or of which he is to dispossess the enemy.

Another form of error may be noted in the suggestion of Signor Brin, the eminent naval constructor of Italy, and the designer of her great ironclads. This gentleman makes concentration of fighting force a reason—or excuse—for building enormous vessels, claiming that in this way great war power is compacted and handled by one chief. He claims thus to carry out the Napoleonic maxim of concentration, and advocates, I am told, still larger ships for the future. The logical result would be a navy consisting of one ship half a mile long by an eighth of a mile beam. Seventy years passed without

naval warfare will account for these ideas being listened to by intelligent minds. Signor Brin's logic will, I am sure, fail to convince those persons much of whose lives have been passed afloat. What may come should the square formation prove successful, and other nations adopt it, it is needless now to inquire. Should ideas change, there would still be ships to be changed, and, after that, years of incessant drill afloat before tactics could be changed, and a whole Navy thus become expert and sea-hardened in its work. Should foreign ideas begin to change, it would then be time enough to think of an enemy's fleet approaching ours in a formation as solid, compact, and easily handled as our own. The time would be so much the longer, since entire conviction and desire to change would only come to them through crushing defeats of their formations by our more compact order—and hence, a resulting increase of time needed to build and man and drill new fleets.

I should be glad if our country might be the first to grasp the new methods demanded by new circumstances, and to see that the great, the masterful, power which steam gives us in place of sails is the ability to concentrate, to move swiftly here and there, still concentrated, and, finally, to strike the enemy almost as a solid mass.

I have desired to place before the members of the Institute this idea of a battle order as a fundamental one, and I leave it, therefore, for their reflection just as it stands, bare and unembellished; and I do this with intention. Many valuable additions may doubtless be made. A Polyphemus may be stationed at each angle of the square; a torpedo flotilla may hover in the rear ready to close when the smoke of hot action shall hide its approach; light and swift vessels for scouts and skirmishers may be added most effectively. These are the adjuncts of a fleet, however, not the fleet itself; and yet, it has seemed to me that for some years past the best intelligence of our Navy, its brightest minds, have concentrated their attention upon these adjuncts, rather than upon the fleet itself. Some officers have gone so far as to doubt the occurrence of fleet fighting in any future wars of the United States, and deny the necessity of preparation for it. I will not attempt to combat this error—this idea born of half a century's disuse of great maritime warfare, and opposed to the unchangeable doctrines of all warfare, which demand concentration of force as of first necessity. But that such ideas exist makes me the more satisfied to have had the privilege of setting before the Institute, in the present haze of doubt and speculation, a plain formation for battle

as a central fact, a thing to be reached out after, and which once established, will make many of the lesser problems easy of solution.

I do not claim that the solid square is the best system—I hope some one will soon suggest a better—but *something* of that kind must soon be obtained. The logic of the situation is plain. Warfare demands concentration. Concentration demands many ships in a small area, moving with swiftness, docility, and as one body. To meet this demand, the ships must be all extremely handy and all exactly alike, and squadron drill in this battle formation must be incessant. To those who agree with me, the practical results of this logic will be plain: we must *build and drill a homogeneous fleet* to the highest point of *evolutionary efficiency*. What should be the units composing this homogeneous fleet, it is not within the scope of this paper to discuss. The necessities of such a fleet, however, the resources of our nation, the known fleets of possible adversaries, are elements which would make it simple to define and describe the general type desirable and necessary.

I have laid before you a simple though difficult formation; it is crude, as all warfare is crude, but I believe it to be effective—unpolished, not unfinished. Let us seek, then, for the rough essentials of success first, afterward for those finenesses which are secondary; do not let these secondaries occupy us too seriously. Think of warfare not as of the watchmaker's trade, nor of the sewing-machine factory, but as of iron forging, where heavy and crushing but inexact blows are struck. War is a rough trade. Let us not ask for a razor edge upon our heavy cutlass. Let us not dream that fleets will ever lie three miles apart and let the finer-pointed gun-sights decide a battle. Great results are not thus attained. Battles of nations are not thus fought.

DISCUSSION.

Commander HORACE ELMER.—*Mr. Chairman and Gentlemen:*—It has given me great pleasure to hear an essay upon Naval Tactics read before this Institute. It is a subject that seems to have been much neglected in the service of late, very naturally, perhaps, in view of the paramount importance of first obtaining ships and guns; but as now we seem to be in a fair way for getting a new navy, it is time we were thinking about how to fight it. It is especially pleasant to find an essayist of such decided views so frankly inviting criticism. I shall accept the invitation in the same spirit it is given.

I find that I disagree with the essayist so radically that it has been difficult, in the short space allowed for discussion, to arrange my remarks. Concentration is his text, and certainly the squares which he proposes as tactical units are the perfection of concentration; but it seems to me that in the importance he attaches to concentration, particularly in the lessons drawn from warfare on shore, he confounds strategy with tactics. It is, indeed, a Napoleonic maxim, verified too often in late wars to be gainsaid at this time, that victory goes to the heaviest battalions, and the general who, by happy combinations or rapid marches, can oppose twenty thousand of his own men to ten thousand of the enemy, has the victory already won; but when once opposed to the enemy in the open field, the domain of strategy is over and that of tactics begins; and in tactics, the experience of all recent wars has been in favor of thinner lines and greater dispersion, until now lines of battle have become nothing more than clouds of skirmishers. The Macedonian phalanx, as a tactical unit, much resembles the solid square proposed by the essayist, yet I scarcely think any army tactician would be bold enough to advocate a return to it at the present time.

In the days of Nelson and Vincent and Howe, there was virtually but one type of battle ship in all navies, and but one weapon to fight with—the gun. The ships were as nearly alike in all their qualities as the builder could make them; there were no hot journals nor sudden variations of steam at critical moments: they were all driven by the same wind and handling alike; nothing but good seamanship was required to keep them together; in other words, it was all in the hands of the captains. They had but one weapon to meet—the gun—and that effective only at comparatively short range. The battle tactics for such a fleet were easily comprised in the words of Nelson: "No captain can go far wrong who places his ship alongside that of an enemy." But at present battle ships are not built alike, nor is it probable they will be in our time. Old weapons have increased in power, new ones are developing. The high-powered gun, the torpedo, the ram, call not for a return to old principles, but an entirely new departure.

I will not dwell upon the practical difficulties to be encountered in keeping a fleet in such close order; that they will be great, the essayist acknowledges, and says that nothing but constant, unremitting drill will make it possible. Is it probable that all our heavy war ships, when built, will be kept constantly in commission and in fleet drill? Is it not more likely, judging the future by the past, that many of them will have to be put in fresh commission at the outbreak of hostilities, and, with others hastily gathered from different parts of the world, form our fleet? Would these tactics be practically possible under such circumstances?

The essayist acknowledges that the square would form an excellent target for the concentrated fire of the enemy's guns, but seems to rely upon wildness of fire to make the risk as little as possible. This is one great weakness of this formation: it makes no allowance for the accuracy and power of the new ordnance. A square of sixteen vessels in close order would extend at least a third of a mile in each direction. It would be exceeding poor practice that

could not hit somewhere inside of that, even at long range, and the Whitehead torpedo, however unreliable it may be, fired at ordinary targets, could scarcely fail to hit something, if directed at such a compact mass. Let us imagine for a moment the effect of such a hit disabling any of the leading vessels as the square comes down in compact order, at full speed, to the attack: the vessels in rear would pile up on those in front, or, in their endeavors to avoid collision, the square would be broken up in confusion. It would not need a Whitehead or even a well-placed shell to accomplish this: a hot journal would be almost as effective. The essayist admits that such a formation will not do for defensive purposes. I am perfectly willing to admit the importance and desirability of taking the offensive wherever practicable; but it is not always so, nor does victory lie always with the attacking fleet. I might instance, as bearing some resemblance, on a small scale, to Aboukir, the battle of Lake Champlain, where the attacking fleet, of the same nationality as at Aboukir, came down to the attack in the same gallant manner, bows on, but were defeated, probably because the gunnery practice was better.

Again, another fact which renders these tactics, even if theoretically desirable, practically impossible in the near future, is the admission of the essayist that the "fleet must be homogeneous, that vessels of great handiness and exactly alike must be built to make the handling of such squares possible." This, then, postpones the adoption of such tactics until the vexed question of construction is settled, and the best type adopted, if any such single vessel can be found. I feel safe in saying that will not be in our time. The rapid development of weapons of offense and defense makes the selection of any such single type more difficult every year.

I will now consider for a few moments the practical application of these tactics to battle as illustrated in the case proposed by the essayist; but, before going farther, I must protest against this idea of feinting at one wing and attacking another while charging down upon the enemy's line. Would a regiment, in column of divisions closed in mass, charging an enemy across an open field, first oblique to the right and then to the left, thus remaining under fire twice as long as necessary, in the vain delusion they were deceiving the enemy as to the point of attack—or, to make the analogy more complete, suppose the enemy on the other side were advancing to meet them—would not these oblique manœuvres be considered quite extraordinary? It seems to me as unreasonable to suppose that any advantage could be gained by thus manœuvring a fleet in the open sea and in the full presence of the enemy. In a fleet of sixteen vessels in order of battle, say in two lines indented, the vessel on the extreme right is well within the range of the guns of the vessel on the left, and the time distance between them at 12 knots is less than four minutes; so that one portion of a fleet can scarcely be crushed while the other is left out of action. That much, steam and high-powered guns have accomplished; and the more thoroughly we realize that fact, the truer, in my opinion, will be our conception of tactics. When once the formation for attack is decided upon, and the time for making it, the less manœuvring the better. But let us analyze the case proposed by the essayist: A fleet of sixteen vessels in close order (a solid

square), steering south, is approaching an enemy at high speed, say 12 knots; the enemy in line at the same speed. This will bring them together at the rate of a mile in less than 2½ minutes. The admiral in command of the square (I quote from the essay) signals fleet SE., when the sixteen vessels will change course simultaneously four points. To accomplish this, even with steam steering-gear, would take probably one minute. Then approaching still closer, the enemy's fire becoming hot, the admiral signals fleet SW., and these sixteen vessels turn eight points to starboard not instantly—nor in any degree resembling a school of fish, but through an advance of perhaps one thousand feet and a time of at least two minutes. I allow the shortest appreciable time for reading and answering the signal. If the fire was hot at the beginning, the fleets are certainly together before or by the time the turn is accomplished. The vessels of the square would have scant time to steady on their new course when the shock came. There would be little opportunity for deployment, were such a thing contemplated. The vessels of the enemy's left wing would meet them stem to stem, having but 45° to turn, while the square turned 90°, and the vessels of the right wing would bear down with their rams (turning 45° with starboard helm) upon the exposed broadsides of the left vessels of the square. It is not difficult to imagine what would become of this solid square after the first shock, should it ever succeed in reaching the enemy's line without being broken up. It seems to me the vessels would be piled upon one another in inextricable confusion, impossible to reform. Suppose that the leading vessels meet the rams of their opponents fairly: those in rear—for the formation is in close order, four deep—must get out of the way immediately or run into them. The time is fearfully short, and the fact is, there is no chance for any but the outer ones, in so compact a formation, to get out of the way; and they will have the rams of the enemy's right wing to meet. It must not be forgotten that the admiral in command of the square, though under fire confessedly hot, cannot use his own guns. He would not dare to run the risk: the smoke would hide his signals and, covering his square, render such delicate manœuvring impossible. These tactics, then, ignore whatever advantage there may be in long range and flat trajectory, and use the gun only when broadside to broadside, as in the days of the old carronades.

About two years ago I had the honor of reading a paper before this Institute on the subject of Naval Tactics. I then stated that, in my opinion, "concentration is the fallacy we are most likely to fall into by too closely following the military idea, and that it would seem a fundamental rule for all orders of battle that no vessel of a fleet should be in the water of another." Time and considerable thought upon the subject have only strengthened this conclusion. In view of the acknowledged unhandiness of the English groups of three, in the form of a scalene triangle, I then suggested that the groups consist of two vessels and the fleet be divided into pairs, as the best development of the group system. This was not a new idea, I discovered afterwards, having been proposed some years before by a French writer on tactics; but I was none the less pleased to hear, as an evidence that my prophecy as to the true evolution of modern tactics was not far wrong, that the English fleet, in their evolutions

last summer, under that distinguished tactician, Sir Geoffrey Hornby, discarded the group formations of three entirely and adopted a formation by pairs.

A theoretically perfect tactics should permit us to use to the best advantage all the weapons with which we are provided; formations should be flexible, not easily destroyed, quickly reformed, adapted to defense as well as offense, and, to use the language of Admiral Randolph, R. N., "affording the utmost freedom to each ship of increasing or reducing speed, as well as altering course, or hauling out of action if disabled." It seems to me that the formation in solid squares answers none of these requirements.

Lieutenant H. O. RITTENHOUSE.—*Mr. Chairman and Gentlemen:*—Success in battle is the supreme consideration which should control every detail in the organization and development of naval force. The most vigorous and effective application of this force being no less essential to success than the possession of the force itself, we cannot afford to neglect the consideration of any system of tactics which might conduce to victory.

Of the value of concentration there can be no question, but I apprehend that it is concentration of attack rather than concentration of force which is generally regarded as a necessary condition of success. I make this distinction for the purpose of simplifying the discussion, and by no means as a criticism, for, if I understand the writer correctly, he advocates the massing of his force not because he regards the mass as an element of strength in itself, but because he believes it to be the best formation from which concentration of attack is made possible. Indeed, he plainly recognizes that this massing of material, and consequently of people, is in itself a source of danger; but he takes the risk of all its dangers in the hope of securing at least compensating advantages. It is at this point that I am unable to follow to his conclusion. I think too great a value is placed upon the advantages to which the system may lead, while its disadvantages are underestimated.

Whatever its merits or defects at other times, it must be judged alone by its qualities as a factor of battle. The advantages claimed are, that it enables the Admiral to make feints whereby the enemy may be deceived, and, finally, that a part or all of the vessels may be suddenly deployed in close action upon a selected portion of the enemy's force. I think these advantages are deceptive. To illustrate by the examples cited in the paper, we suppose the feint has been successful, and the reserves are hastening in one direction, while the real attack soon takes place in another. During this contest our vessels receive *some* damage, at least, and although the enemy's reserves arrive later, they are fresh to fulfil their important duties at a possibly more critical and decisive moment than if they had been engaged at first. Likewise, the advantage of throwing a superior force upon a smaller number of the enemy, whereby the enemy is left to throw *his* superior force upon the residue of our fleet, is not obvious. I do not go so far as to say that there can be no advantages in such measures, but only note that such advantages are not as great as they are sometimes thought to be.

The building of a fleet designed to fit a plan of tactics can be justified only

by showing that the advantages of the tactics are so great that all conflicting considerations should be subordinated to such plan. When force meets equal force on the open sea, attempts at deception will avail but little. In operations on shore, the topographical features invite and require the use of strategy; but at sea nothing is concealed, and when equal fleets meet on such even terms, the laws of compensation are so uniform that we are led to look for success in the more rapid and skillful handling of our rams, guns and torpedoes, rather than by any devices of manœuvring. The disadvantages which attach to the formation in solid square are numerous, and, I think, of greater moment than the paper discloses. We are met at the outset by the admitted fact that a fleet must be constructed to conform to the tactics, and no stronger statement can be made of the practical difficulties of the formation. If ramming is to constitute a material part of the action at close quarters, it is likely that the vessels of the homogeneous fleet would be fitted, to some extent at least, for such work—a fact which increases the difficulty, not to say danger, in time of peace, and might lead to confusion, if not disaster, in time of action.

To produce confusion, it is not necessary that accident should happen to one of the interior vessels of the square. An accident to any vessel, excepting those which happen to be in the rear, when steering a given course, would be equally unfortunate. It will be remembered that in the galley conflict referred to, the disastrous confusion was not due to a cause originating inside.

While the mass offers an attractive target to the enemy even at long range, it will be seen that the fire from the mass will be very much restricted, and when the fleet is steering on lines of the square or parallel with either diagonal (it is not probable that other courses would be in much use), the fire parallel to the keel would be restricted to a portion only of the outer lines.

Lieutenant CHARLES R. MILES.—*Mr. Chairman and Gentlemen:*—The question brought before us this evening presents a wide field for discussion, and the student of naval warfare must confess himself bewildered at the great number of intricate problems to be considered before anything like a definite conclusion can be reached in regard to the subject. The existing jealousies of the great powers of Europe may, at no distant day, give some of the well-equipped fleets of the period an opportunity to furnish us with valuable practicable lessons in battle tactics; but it will not be wise for us to pursue a "waiting policy," lest we ourselves should first be called upon to furnish those lessons and be found wanting. Naval officers have been urging upon the American people for years the necessity for building modern ships of war, and now that the prospect seems good for having a fleet of these ships entrusted to our care, it becomes us to look fairly at this question of battle tactics, and, by freely discussing it, to endeavor to form some idea of what tactical formation will be the best to fight successfully a modern fleet.

The paper under discussion presents very forcibly the value of compact formations for battle, but I doubt very much whether a candid consideration of the advantages and disadvantages of the solid squares will be in favor

of the adoption of such formations for battle. It appears to me that the only solid squares that are at all practicable are those composed of four and of nine ships. The former, that of four ships, has the disadvantage I should urge against the group system—that it would break up the fleet into small, detached squadrons, thus destroying its unity, and rendering it liable to be beaten in detail. The latter formation, that of nine ships, has a great disadvantage in having so many ships whose guns cannot be brought to bear upon the enemy while approaching him. This makes a very desirable formation to manœuvre from when the enemy's line of battle is reached, as illustrated by Commander Taylor in Figs. 12 and 13; but imagine the disheartening effect produced upon the officers and men of the silent ships in the rear and centre by being exposed to the galling, concentrated fire of the enemy without an opportunity to strike back until the enemy's line is reached.

I am disposed to favor concentration in the abstract, however, and believe that some other form of concentration not having the disadvantages of the solid square will be found in future fleet actions to possess the essential elements of success. I place much force upon the effect of breaking the enemy's line, should the enemy form in lines abreast in open order; for, with this feat accomplished by a fleet in compact order, the battle is half won. One of the principal axioms of warfare, be it on land or at sea, is that we must endeavor to catch the enemy unawares by out-manœuvring him, and then to overwhelm a portion of his force by the whole of our own. In order to accomplish this result, concentration must be resorted to at the critical moment of the final charge. Open-order formations may be employed as a means of spreading the fire of the enemy's fleet while endeavoring to out-manœuvre it, but they must be such open-order formations as will render it possible to form rapidly into the most advantageous compact order for striking the enemy the decisive blow when the opportune moment arrives.

All open-order formations are based, I take it, upon certain well-known principles of modern military tactics, but the advocates of these formations for naval battle tactics forget the difference in the character of the battles on land and those on the open sea. In the former, the conformation of the land, the presence of trees and of fortifications, etc., render the approach of an enemy slow and cautious, while the army acting on the defensive has a decided advantage. In the latter case, there is a smooth, unbroken surface, with no obstacle save the enemy's guns to prevent the two fleets from coming rapidly together. It, therefore, appears to me that we should liken naval battles to the cavalry charge, made by compact bodies moving at full speed, sweeping all before them, rather than to the movements of the slowly and cautiously advancing infantry in skirmish line.

I believe long lines either abreast or ahead to be very weak formations in which to make or receive an attack. First, because naval actions of the future, as Commodore Taylor says, will not degenerate into mere target practice at long range; for, with the great speed of the modern battle ship, and with the possibilities of her offensive weapons, the gun, the ram, and the torpedo, well considered, no commander, hoping for success, will hesitate to bring into effective

co-operation all the resources thus entrusted to him. It is needless for me to refer to the impotency of the ram and the torpedo at long range, or to their deadly effectiveness at close quarters, except to draw the conclusion more forcibly that, in order to produce the most effective co-operation of all the offensive weapons in a modern fleet, the commander must seek close action, and the earlier he brings his rams and torpedoes to the assistance of his guns the better, always providing that he obtains the advantage of position before doing so. The advocates of open order lay much stress upon the immunity thus obtained from the evil effects of concentrated fire, forgetting, apparently, that the time during which a fleet will be exposed to such a fire at anything like a comfortable distance for cool target practice will be very short indeed. Secondly, the line abreast, either with vessels in groups or in *echelon*, it seems to me, does not possess the necessary element of unity. The commander-in-chief does not have his vessels so much under his own control as in the compact order, and, as future actions will be fought, in all probability, in less time than even the most decisive battles were fought in the past, the necessity for compactness, to prevent early demoralization in the fleet, seems imperative.

I wish to propose, in place of the solid square, the double-*echelon* formation of two indented lines; or, to make my meaning clearer, I would form the fleet in two wedge-shaped lines, one within the other, the apexes towards the enemy, and the sides of each wedge making an angle of 90°. The vessels of the inner line must take position opposite the intervals between the vessels of the outer line, making, as it were, two bow and quarter lines of vessels on each side of the wedge. I claim for this formation, which I shall name the battle angle, the following advantages:

1. The formation is compact and can be easily manœuvred.

2. All the vessels will be able to use one broadside and their bow guns while bearing down upon the enemy.

3. When the enemy's line is reached, each vessel in the rear can continue on her course without fear of colliding with a vessel of her own fleet, and thus use her ram and torpedoes most effectively at the first onslaught.

4. The angle within the inner line can be used as a shelter for the more lightly armored torpedo and dispatch boats and rams.

5. It affords abundant opportunity for the display of strategy, in breaking through the enemy's line and doubling on one wing of his fleet.

I wish here to take issue with Lieutenant Rittenhouse in regard to the importance of strategy in fleet actions. Of course, strategical manœuvres are much more difficult to accomplish on the open sea than on land, but the commander of a fleet must employ strategy as well as tactics, if he hopes to win victory. I hold there is plenty of room for the display of strategy in manœuvring a fleet to outwit an enemy; and, although it may be difficult to deceive the enemy, yet that does not furnish sufficient excuse for neglecting to make an attempt to do so.

As the formation I have proposed would probably draw the concentrated fire of the enemy, while bearing down upon him the fleet might be deployed into two lines abreast in open order, preserving the relative positions of the

ships in the two lines as they were in the wedges. This formation could be maintained until near enough the enemy to discover the weak points in his line, when the fleet should form the battle angle again upon some designated ship, presumably the one opposite some weak point in the enemy's line.

I wish to state here that the formation I have advocated in line appears to be identical with that advocated by Commander Elmer in his paper on Naval Tactics, printed in No. 30 of the Proceedings of the Institute; and, further, that my formation of the wedge is simply that line formed in double *echelon*. I make this statement in justice to Commander Elmer, although, when I first conceived these formations, I had not seen his article.

I do not wish it understood that I advocate a rigid adherence to concentration under all circumstances; but this much I wish to assert—that, while the position of the enemy's fleet and the strategical intentions of the commander-in-chief may demand the open-order formation for the purpose of manœuvring into position, the concentrated, compact formation will be successfully resorted to for the final attack. After the fleets close and the signals become obscured, the fight must become a *mêlée*, and the best advice then, perhaps, for the individual commanders will be that given by Nelson to his captains at Trafalgar.

It may be a little irrelevant, perhaps, in this discussion to speak of the value of our present method of signalling; but as the success of fleet manœuvres in the future must depend upon the rapidity with which signals can be made and received, I shall claim the indulgence of the meeting for a moment longer, while I enter my protest against the continuance in use of the present methods. With two hostile fleets approaching each other at the rate of 12, 13, or perhaps 15 knots an hour, very little time can be given to the making and reading of signals; hence, some new and more rapid method should be devised.

It would be better, however, during battle, not to trust too much to signalling, even under the most favorable conditions. When the circumstances permit, all the possible features of the battle should be discussed beforehand by the admiral and his captains, and then, in case a signal is obscured or is wanting at the critical moment, the captains have their own knowledge of the plan of the battle to act upon. Nelson always adopted this method previous to his great actions, and by so doing he gained the confidence and thorough co-operation of his captains. If such were the case in those days, when plenty of time was given to the reading of signals, owing to the slowness of the approach of two hostile fleets, how much more important—nay, imperative—it is that each captain in the modern fleet should know what to do instantly, without waiting for a signal, when the enemy is approaching at the rate of 15 knots, and is, in all probability, directly upon him in less time than it would take to make out and answer a signal from the flagship!

Lieutenant C. D. GALLOWAY.—*Mr. Chairman and Gentlemen:*—It is fair to assume that the tactics adopted by any nation will be known by all the other nations with which a conflict is likely to take place. This knowledge will enable fleet commanders to make their plans to a certain extent before the action begins.

Let us suppose, for example, two hostile fleets, *A* and *B*, approaching each other, each consisting of an equal number of vessels, say nine, not counting torpedo boats. The commander of fleet *A* adopts the tactics of the essayist, and advances to the attack in a solid square; while the commander of fleet *B* advances to meet him in single line of battle. I here choose the single line to oppose the solid square, rather than the indented or double line, in order that every gun that will train ahead or nearly ahead may be used upon the advancing square, which certainly offers a fine target for even extreme range. While approaching, therefore, the square will be subjected, from every ship in the line, to at least two rounds from each gun that can be brought to bear, while the line will be under the fire of only the leading ships of the square, and will naturally offer a much less favorable target. It is quite possible, also, that projectiles fired into the square may injure more than one vessel by passing through unarmored parts, creating *débris* and confusion, if not doing more serious damage.

Should the approaching square feint on either wing of the line, it will simply hold itself under fire from the whole line for a longer period and suffer more. A very important point to be noted here is the fact that the speed of the vessels of the square will be materially lessened by *any* change of direction, as mentioned by Commander Elmer. Another point to be noted is, that in all changes of direction of four points or more (the essayist suggests a change of eight points when feinting on one wing and attacking the other), as the vessels of the square are in close order, the rear ships in each column must slow almost to steerage way, or oblique at least two points before turning, in order to avoid running into the stern of the leading vessel, because, the pivoting point being invariably forward of the middle of a vessel, the stern of the leading vessel would extend at least 150 feet across the line of her former direction. This alone would greatly enhance the danger of manœuvring the square after the firing began, on account of smoke, as it would also in drill during fog or thick weather. My attention was called to this fact in 1880, by an officer of the Royal Navy attached to one of the ironclads of the Mediterranean fleet. In tactics other than that recommended by the essayist, this is avoided by the change of direction being more gradual, the vessels really steaming on an arc of small radius. Even in the square this is practicable, but I think the necessity for it increases the danger of fouling, and renders the fish-like manœuvring less practicable.

Let us now suppose *A*'s square has attacked the left of *B*'s line, and, while it is thus occupied, that the latter's right wing attacks the left flank of the square. Only the outside vessels of the square, in this case, would be able to do much execution, while the torpedo vessels belonging to fleet *B* would sweep around upon the right flank of the square, either attacking the vessels of the square on this flank or its torpedo boats; or else they would divide their attention between such an attack and in defending the vessels of their own right wing against an attack from the torpedo vessels of the enemy. Any damage thus done to the outside vessels of the square would materially weaken the effective force and utility of the inner ones, while any damage done to *one* of the vessels of

B's line would simply amount to the loss of *one* vessel. Should, however, the square break through the line, and assuming that it has swept away the vessels in its immediate path, suffering naturally some loss, the remaining vessels of the line need simply change from their original direction 16 points, and attack the rear of the square, continuing the attack while fleet *A* is reforming its square, or any other form of concentration demanded by the tactics proposed.

It appears to me that the tactics of the essayist subjects the vessels of *A*'s fleet not only to the entire force of its opponents, but also to the great danger of being destroyed by its own auto-mobile torpedoes, or of being fired into or rammed by its own vessels.

Lieutenant D. H. MAHAN.—*Mr. Chairman and Gentlemen:*—Besides the compact mass proposed by Commander Taylor, and the other formations suggested, I would like to propose a plan embracing the good points of both, as I think, and I hope I may either render my position good or receive such suggestions as may cause me to change my opinion. It is said, "In time of peace prepare for war"; so let us fight our battles to come now, that in the future we may be able to talk over our successful battles which have been.

The plan I would propose is, having nine ships, or any other number (but I take nine to place against Commander Taylor's nine), let us arrange them in a combination of two of the plans suggested, the double *echelon* and a partial line of battle; the centre three in line of battle, the two wings in *echelon*. This is the cruising formation, two or more cables' lengths apart both abeam and from astern to ahead. This formation of fleet can be more easily managed than either of those proposed. It is easy to form line of battle by the vessels in *echelon* moving at full speed into line. To change direction even to eight points is accomplished without the ahead and astern dilemma, and the position of *echelon* can be quickly regained by the wings. In all changes the three centre vessels wheel as one into the new formation, except when the signal, "Vessels right, or left, about" is made. For instance, there is a fleet in this formation heading E.; speed 9 knots, greatest possible speed 14 knots. A hostile fleet is reported from aloft bearing SE. Our admiral signals either, "Fleet SE. in *echelon*," or, "Fleet SE., left support." If the first is made, the centre wheels until heading SE.; the right slows until position is gained; the left increases speed to take position. If the second is made, each vessel of the right wing changes course to SE.; the centre wheels four points to SE. The left wing changes direction—No. 1 to SE., No. 2 to SSE., No. 3 to S. by E., forming in rear of the line of battle formed by the centre and right wing, on a line of bearing NE. and SW., and four or more cables' lengths in rear of that line of battle. On attack, these three vessels are held in reserve according to instructions well understood beforehand.

If it is found that the enemy is advancing in mass or square of nine vessels, I would attack in the *echelon* formation, and (the mass tactics being well understood) our captains would only have to consider what possible change would be made by the enemy. If the enemy should feint to the left, as his first change, it may be considered almost certain that his time will be too short to

attack the right; it is far different now from "Feint left face, cut right"; the distance travelled over by ships at full speed seems to have been disregarded by the writer. Our fleet has so far been advancing at 9 knots (the best manœuvring speed) in *echelon* formation; our admiral signals, "Full speed." This means he has determined to attack, and it is well understood that he will, with our centre, attack the enemy's van. Ram, if possible, is the order. The captains of the centre know this. There is no other signal to be watched for: all attention is given to the enemy. Fire is to be reserved until close aboard. Our centre strikes the enemy's van; the centre and rear of the enemy have to sheer boldly to the left and right, to avoid collision with their own vessels. Our right and left are advancing at 14 knots, straight as arrows, only allowing sufficient helm to strike decisive blows on the enemy's bows now open to us, and the result is what? 1st. The probable loss of our three centre vessels. 2d. The probable loss to the enemy of his three van vessels; three of his vessels, trying to escape to the left, run down by our right; three of his vessels, trying to escape to the right, run down by our left. The captains in the enemy's fleet have been trammelled by signals expected from their admiral. As soon as it is seen that they are bound to be hit by one of our approaching vessels, an effort is made to secure the best possible position to receive shock, but too late.

Suppose, however, that the position on heading SE. were the second, "Fleet SE., left support." Our centre would again attack the enemy's van. Our right would converge to attack the enemy's ships diverging towards it, or, better still, away from it. Our left, as support, has such a position that it can be moved to the right or the left, or support the centre by engaging any vessels which may have slipped through. Our left has also the advantage of being free from smoke and with more room to manœuvre. If, before the attack, the enemy should have changed so much to the left as to cause change of formation, the signal could be made, "Fleet E." or "Fleet NE.," when the centre and left would be in line of battle and the right wing in support. Readily concerted signals could be determined upon; for instance, "Full speed, left" would mean, "The left will attack enemy's van, fleet full speed to attack."

By these changes every movement is an advance, and only the vessels farthest from the enemy have need to slow down. Never make a movement in retreat when near the enemy. Nos. 7 and 8 of the writer's figures are just the positions I should like to see an enemy's fleet take, if I had a fleet of strong, swift ships close to it. By having a general understanding as to the movements of individual vessels, the necessity of signals can be done away with to a great extent. An admiral must depend upon his commodores and captains, and he can soon determine upon the character of each and assign them positions best suited to them. In such an engagement as I have described, the man who has the most grit will win. If the enemy's admiral falters, no matter how little, so much the worse for him. If our admiral falters, there is still a chance for us from the pluck of the commodores of the right and left wings.

If it is necessary to change course 16 or 12 points on sighting an enemy, signal, "Fleet W., vessels right, or left, about," whichever gains ground towards the enemy. Let us say right about, for example: then all turn one-

half circle to right; on completion of turn the centre advances at full speed; each of the other vessels takes up full speed, so as to retain position in *echelon*, heading W. Now the manœuvres can be resumed so as to head SW. or NW., or as you choose.

These few remarks are made to show that this formation has the following advantages: 1st. No ahead or astern line, unless one wing acts as support, and in that case the support is sufficiently far from the main fleet to avoid fouling. 2d. Easy to change to another formation. 3d. More space given for calculation than in mass or line of battle formation. 4th. Being in open order, there is less liability of being struck by a shot intended for another vessel.

Commander H. C. TAYLOR.—*Mr. Chairman and Gentlemen* :—In the opening remarks of my paper I stated that my ideas were not at all in line with modern naval thought. In other words, I quite expected the severe criticism which this discussion has developed. This criticism has come from most able and intelligent officers. It is in all probability correct and just, for it expresses the sentiment of a majority of the thinking men of our Navy. While unable to change my own convictions, based upon some experience, thought and study, I shall not imitate the solitary juror who complained of the obstinacy of the eleven other jurymen. I shall, therefore, make some explanations and clear away some misapprehension of my meaning, not hoping, however, that even then we shall be much closer together.

In the first place, when it was determined to build a navy, and suggestions were invited as to future ships, it seemed to me a logical course to consider what future fleets could inflict most damage upon an enemy; and to consider then what form and class of vessel would make that future fleet a possibility. To determine what form or method of fleet was best for our needs, it seemed logical also to observe the European armaments, to note without prejudice the points where they have failed to obey the great laws which thousands of years of warfare have made for us, and, avoiding their defects, to prepare by more skillful methods to take advantage of those defects in case of a future war.

Thus, my desire being to deduce the ship from the necessities of the fleet and its tactics, I am quite at odds with the excellent and valuable remarks of Commander Elmer, which open with the statement that naval tactics have been "much neglected in the service of late, very naturally, perhaps, in view of the paramount importance of first obtaining ships and guns." He intimates that a fleet of Nelson's or Howe's time was more easily kept together than a modern steam fleet, being driven by the same wind, and having no hot journals to contend with. I cannot agree that this is a fact. I think flaws and baffling winds were greater enemies to compact formations in the days of sails than are the steam accidents of the present day. That battle ships are not built alike is in my opinion much to be regretted, but it is, I confess, a good reason for objecting to compact formations. But I urge that they can be and ought to be built alike, in order that we may have and use such formations.

Though I have referred to both the sailing period and the galley period, I should here say that the history and laws of warfare afloat during the galley

period, which counted thousands of years against the sailing period's centuries, have been my principal reliance in deducing effective rules for our present guidance under steam. Commander Elmer believes that "the high-powered gun, the torpedo, and the ram, call not for a return to old principles, but for an entirely new departure." I do not agree with him. Fundamental principles of warfare do not change. No new departure is needed. The gun, ram, and torpedo will work with these principles, or may, perhaps, retard them somewhat, but they can neither change nor destroy them.

The system I advocate does not contemplate for its unit "heavy war ships," as I understand Commander Elmer to use the term. The use of such ships has forced upon European navies formations and tactics hopelessly faulty. Formations and tactics to defeat theirs are possible only with a different unit of fleet, a smaller, cheaper, slower, but quicker-handling unit. It will give me pleasure at some future day to lay before my able critics and good friends a general idea of the unit which I finally suggested as the result of what seems to me a course of logical naval deduction.

I am willing to consider as of great weight the objection to the square as a target for the enemy's fire. I can imagine circumstances in which it would result in the loss of a battle. I consider, however, the advantage I have pointed out to outweigh this defect.

I noted in my paper that there were some rare exceptions to an attacking fleet being successful. The battle of Lake Champlain is one. A few others are recorded in naval histories.

I contemplate the changes of direction referred to by Commander Elmer as being made while out of close or destructive range; and I expected the turnings to be made *simultaneously*, not, as he seems to think, *instantly*. To go further into possible details would prove too great a trespass upon your time. It is evident to me, however, that the power of feinting with a compact formation may be employed when at a long distance from the enemy, and to such a degree as to throw into serious confusion any elongated formation which attempts changes of front in order to meet the attack. I had no wish to ignore long ranges and flat trajectories, but one of my chief purposes was to protest against the undue weight given to this and other improvements of details, in considering methods of fighting. It is asked, Would regiments, in charging, oblique in order to make feints? Had these regiments means of being transported smoothly and swiftly across the space intervening between them and their enemy's line, it is my opinion that they would employ this obliquing though exposed to heavy fire while so doing.

The explanations I have made in answer to Commander Elmer's criticisms will cover much of the ground of the remarks of the other officers—remarks giving evidence of careful thought and a thorough understanding of the subject. I wish to accede at once to the statement of Lieutenant Kittenhouse that it is concentration of attack rather than concentration of force that is to be desired and sought for. I recognize, also, the wisdom of his remark that "the building of a fleet designed to fit a plan of tactics can only be justified by showing that the advantages of the tactics are so great that all conflicting considerations

should be subordinated to such plan." But my claim is that any ordinary system of tactics will have those great advantages if it is made effective by building ships and fleets to fit it.

As regards Lieutenant Miles's valuable suggestion of a double wedge, I have only to say that if the angle of the wedge is 90°, he produces something very similar to the half of a solid square. I desire compactness, but have no special fondness for the square, and am quite ready to believe that the wedge may prove highly effective. The instant, however, it is attempted to fill in the space between the wings by weaker vessels, his formation has the same defect as the hollow square proposed some years ago by Lieutenant Mason, who filled the inner space with vessels not belonging to the formation proper, and thus effectively separated the sides of the square from each other and prevented mutual support. Omitting this feature, the hollow square is not an undesirable form of concentration, and with the same omission I consider Lieutenant Miles's wedge practicable and effective.

In Lieutenant Galloway's discussion of this formation, he expresses a belief that vessels would run into the sterns of their leaders. If I understand him correctly, he has misapprehended my meaning. I have not deemed it possible to have any wheeling or following of leaders in a compact formation like this. At the signal, "Fleet NW.," each vessel turns NW. at the same moment, preserving unchanged the bearings of the lines and columns. It is not intended that any ship should continue her course until she arrives at the point where her leader turned, and so run the danger of fouling him. Lieutenant Galloway also suggests that after the square has attacked the enemy's left, the enemy's right wing may attack the left face of the square. In answer to this, I may say that before delivering the attack the square would disengage and reach the enemy's front in detached lines or columns, as shown in the figures.

Lieutenant Mahan has suggested a formation which appears to me to have much strength, but I am disposed to believe any formation defective that calls for wheelings and new alignments while manœuvring in the presence of an enemy. This it is that has made me desire a formation which need not be changed during preliminary evolutions. I have not disregarded the short times and great distances of our modern ships at full speed, but have, on the contrary, felt that fact to constitute a great danger to wheelings and fresh alignments.

Throughout this discussion, from which I have derived great benefit, though not a change of opinion, I seem to observe that the examples of European navies have considerable influence upon the views of our officers. This is natural; but I submit that it is not wise to defer too much to systems of warfare which have never endured the tests of war. English admirals have used their skill as tacticians to procure the best formations possible with such units as they possess. Nor am I surprised that their conclusions should nearly coincide with those of the talented officers of our own Navy, whose study of the subject makes their criticism so valuable. But if their units are oversized, clumsy, and expensive; if the fleets formed of them are strangely ineffective in proportion to their cost; if their tactics are vague and feeble; and, finally, if we, having no units, no fleets, no tactics, are about to get them, why

shall we not first say what tactics and fleets will prevail against European systems, and then provide the unit ships of a kind to make those fleets possible? Whatever we may decide, therefore, as to the best fleet and formation, do not let us so decide because the "modern ship" will or will not fit it. However great may be my error, this would be a greater one.

The CHAIRMAN.—*Gentlemen:*—The discussion has anticipated many of the thoughts which had occurred to me with regard to the subject under consideration. Another form of expression may, however, give some interest to a brief statement of ideas which have been presented already so well and forcibly.

A fleet of sixteen vessels in single column, at one cable distance, occupies a length of one mile and a half. If formed in square, at two cables' distance, which may be estimated as the least distance, in that order, for manœuvring under steam and at full speed, the side of the square would be six and the diagonal eight and a half cables. In the first formation, supposing the van ship at rest, the rear vessel, at a speed of twelve knots, would reach the van in seven and a half minutes. If the leading ship proceeds at half speed, the rear ship would require fifteen minutes to overtake the van. Similarly, if in square, steering in the direction of a side and its parallels, the rear squadron could reach the van in from three to six minutes. In the old battle formation, a single column upon a line of bearing, the ships to leeward were liable to be thrown out of action, a disability which, it is evident, could not be imposed upon a steam fleet of the present day. These two formations, the line of single ships and the square, present the extreme cases of dispersion and of concentration of the fleet.

The square insures the advantages of simplicity in manœuvring and deployment of divisions, of close supervision by the commander-in-chief, and of bringing with the greatest rapidity one part of the fleet to the support or relief of another. It imposes some disabilities. The ramming power of a fleet of sixteen vessels in square is reduced, primarily, to that of four ships, if steering upon a side of the square and its parallels, or to that of seven vessels, if heading in the direction of a diagonal. Similarly, the amount of gun fire is reduced as follows: In a square of four vessels, one-half or one-fourth, according as the ships head in the direction of a side or a diagonal; in a square of nine vessels, two-thirds or four-ninths; and in a square composed of sixteen vessels, three-fourths or nine-sixteenths, respectively. The inner ships lose all their circle of fire. Indeed, it does not appear that the enclosed vessels have any defensive power while that formation is maintained, nor any offensive power, except that of proceeding to points where their latent force may become effective.

The square offers a broad mark to the distant fire of an enemy, and, although fleets will probably approach with such rapidity that not more than two rounds may be fired from bow guns, the guns being again loaded and ready for the moment of collision, this must be noted as a serious disadvantage.

In the square, the attention of commanders must be given largely to the relative bearings and distances of their consorts, while in the presence of the

enemy, when his mind should be relieved, as far as possible, from considerations of tactics, distances, angles, and compass courses. The general plans of action will have been formed and communicated by the commander-in-chief to his captains; and, in these last moments, his attention should not be absorbed in manœuvres to attain a battle formation. His efforts should be directed rather to the transfer of his battle line, already formed, to a position from which the attack may be delivered as he would prefer, in the prevailing condition of the wind and sea.

In the event of surprise, as from sudden fog-lifting or at night, with the enemy close aboard, these disadvantages would be, apparently, somewhat increased. It would be difficult to change the formation promptly. The leading ships of the square would probably charge, with an intention of ramming; but it is thought that, in a fleet about to charge, no ship should be directly in the wake of a leader, unless in very open order. The sudden disability of the commander of a leading ship, or any of the accidents of war occurring in the van, might precipitate disaster. The square is considered a bad formation in which to receive a sudden charge of some of the enemy's ships, if equal in number to the front of the square.

The composition of the battle fleet is an essential part of this problem. Some think that each ship of the line of battle will be attended by one or two sea-going torpedo vessels. Others maintain that it will be better to compose the line of heavy ships of great and equal speed, strengthened for ramming, and carrying powerful batteries. The existing opinion and practice appear opposed to the employment of vessels solely as rams, and it is not likely that they will have a place in the line of battle. The naval mind, throughout the world, is bent on ramming with any ship which may enter the line, irrespective of her artillery power; and, for this object, a strong and sharp bow, speed, and weight of vessel, are necessary. These qualities can be obtained without sacrifice of battery.

Let us consider an example of the necessary size and speed of a vessel for effective ramming. At Mobile Bay, the Monongahela, of about two thousand tons displacement, when ramming the ironclad Tennessee the second time, struck her upon the beam nearly at a right angle. The speed of the former, at the moment of striking, exceeded ten knots; but both ships had their helms a-port, the Monongahela endeavoring to deliver a perpendicular blow, and the Tennessee striving to sheer clear of her antagonist or to make the blow a glancing one. At ten knots speed, the perpendicular or direct blow would have amounted to about nine thousand foot-tons. But the blow was not a direct one, and the peculiar form of the Tennessee's side secured great structural strength and resistance. The Tennessee heeled far over and sheered rapidly away from the bow of her adversary. A part of the blow was absorbed in the destruction of the Monongahela's bow. Of course, the Tennessee's side did not take up instantaneously the remaining energy of the blow, but it is thought that had her side been straight it must have been penetrated. The force exerted by a ram, striking perpendicularly, varies directly as the weight and as the square of the speed of the ram. The Trenton could deliver, there-

fore, at a speed of twelve knots, a blow of about twenty-four thousand foot-tons. A large portion of the energy of a ram will be spent otherwise than in producing rupture at the point of impact. But it is believed that only an exterior structure, similar to the wedge shape of the Tennessee's side, powerfully braced upon the beams of a ship, could be hopefully opposed to the direct blow of sixty thousand foot-tons, given by the sharp bow of a ship of six thousand tons displacement, at a speed of fifteen knots.

Assuming that the battle line will be composed of heavy armored ships, with great speed and powerful batteries, does the square provide the greatest development of the ram and the gun, as the two most effective and reliable forces of the fleet? The effort should be to strike as heavy a blow as possible at the beginning of the fight, and we should look for a formation which will enable the ships to deliver that blow in unison. The square does not permit all the ships to participate in an attack, either with ram or guns. But the essayist says, "The square is to be maintained only until close action is joined, when deployment follows, the columns of the square diverge, and each ship takes room for fighting." It is submitted that the deployment is too late, and may result in partial or successive assaults by divisions of the fleet, or in one division sustaining the first onset of the entire fleet of the enemy.

The design and argument of the essayist appear to rest in this change of formation in the immediate presence of the enemy, precisely executed by a highly drilled fleet, thus keeping the enemy in ignorance of the point at which the blow will fall, and taking advantage of any peculiarity of his formation. It is a daring conception. The essayist concedes, practically, that the square can neither attack nor defend, but he uses it as the element from which he will develop his battle in the face of the enemy. The aim is high, and he will deserve success.

The fleet should cruise habitually in the battle formation, and the line of battle should be that in which the offensive and defensive powers of all the ships may be instantly employed. The double line of battle, in which the unit is a group of two ships, exemplifies this principle. Some advantages of this order were ably stated by the present Head of the Department of Seamanship and Naval Tactics, in a paper read before the Institute in January, 1884. It affords some other facilities besides those noted by Commander Elmer. In this formation, the rear ship of a group may keep its station four or five points abaft the beam, or it may be shifted quickly from one quarter to the other. Manœuvring is quite as simple as in the single line. When in double column, the broadsides of every ship are preserved; in line, the way is clear for each as a ram; and, at nearly all other angles, the double *echelon* formed gives scope for all the powers of the fleet. The leading ship has the task of maintaining its correct alignment and distance reduced to the least difficulty. The rear ships have only to watch their leaders and to follow up the attack of the leading line. Angles and relative bearings of ships find their utmost simplicity. The lookout ships should be stationed upon the flanks in front and rear, and, having signalled the number and formation of the enemy, they should assemble in rear of the double line and form, with the torpedo vessels, the reserve of the fleet. The front should equal or exceed that presented by

the enemy, and the reserve of the double line affords a means of prolongation, either deliberately or suddenly, when considered necessary or desirable.

It is thought that the double line gives a powerful concentration, that concentration which subjects a number or all of the enemy's ships to a second blow from the supporting line swiftly following the first, or that other form of concentration which is effected simultaneously by enveloping and turning upon the flanks of the enemy.

Since we must concede to the enemy's ships a speed equal to that of our own fleet, the problem of doubling upon a part of his line has now an additional difficulty. And if one steam fleet doubles on a part of the other, why cannot the disengaged ships double also? If the formation is a good one, manœuvres will not avail much against an enemy of equal force: the victory will rest with the fleet which possesses the superior preparation, cohesiveness, skill, and endurance.

Commander H. C. TAYLOR.—*Mr. Chairman*:—Permit me to say, in answer to your fears that the deployment of the square may be too late and may thus result in disaster, that the deployment would be ordered when closing with the enemy, and the time for it would be determined by the admiral, sooner or later, as the firing became hotter and collisions impended. You consider, very justly, that a powerful concentration is obtained by the double line in attack. I submit to your judgment that the solid square of nine ships only adds another line to your proposed line of attack, while it ensures a formation equal at all points and in all directions.

Commander HORACE ELMER.—*Mr. Chairman*:—I move that a vote of thanks be tendered to Commander Taylor for his very interesting and valuable paper.

The motion was carried, and the meeting then adjourned.

SOME PRACTICAL HINTS ABOUT FORTIFICATIONS.

By J. C. Little, late Captain of Artillery and Ordnance Officer at Fort Fisher.

At the bombardment of Fort Fisher, the ironclads took up a position to the NE. of the fort, and devoted their attention to the land, or north, front of the fort. On this front were some 20 guns, comprising 8-inch Columbiads, rifled 32s, smooth-bore 32s and 24s, etc. All these guns were mounted in barbette, with heavy traverses between the gun chambers. Without any difficulty or delay the fleet dismounted all these guns except one in the NE. corner of the fort. Nearly all, if not all, were dismounted by being struck square on the muzzle by heavy shot or shell. But the 6.4-inch rifle in the NE. corner, though fired at for three days continuously, was never touched, and was in condition for service when the fort fell. I tried to ascertain the reason why this was the only gun that stood, while all the others were dismounted, and my conclusions led me to a new plan for seacoast fortifications.

These barbette guns showed plainly against the sky, the works and gun presenting an appearance like Fig. 1. The muzzle stood out clear and offered a perfect mark, while the course of the shot could also be plainly traced and the aim corrected. Hence, not more than two or three shots were needed at each of *these guns* to disable them. The gun in the NE. corner was *marked* by a traverse behind it, so that it could not be

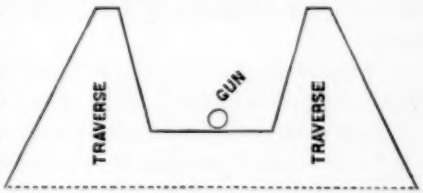


Fig. 1.

plainly seen, nor could the shot (plunging into the traverse) be traced to correct the aim (Fig. 2). When ordnance was such that ships could lie yardarm to yardarm and hammer away for an hour, it was important that seacoast guns should have a plunging fire. Now that vessels can lie off so far, the small elevations of 30 to 60 feet give an advantage very slight—not to be weighed against other and more patent advantages. This advantage my plan sacrifices.

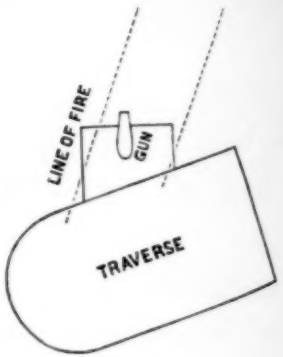


FIG. 2.

I claim for my plan (Fig. 3) the following advantages:

1. The gun, being masked by the main works, cannot be easily struck.

2. The slope of the parapets being parts of the same line, riflemen from their berm can sweep the parapet of the gun works in comparative safety, and aim by night or in smoke as effectually as by day.

3. The magazines, being under traverses between the guns, are safe and convenient.

4. The middle ditch exposes an assaulting column to hand grenades from the rifle berm, or to shells with 3 to 5-second fuses rolled down the slope.

5. Small sally-ports through main works allow easy communication, while an arrangement of the ceiling of the sally-port in shape of a trap would block the sally-port with sand in an instant.

6. Bomb proofs perfectly secure.

7. A middle ditch which could be raked with canister by field guns from either end.

8. An inner covered way which affords safe communication everywhere.

9. Works safe from captured guns, as the guns cannot be turned against the garrison, the interior of fort being secured by main works.

Should it be deemed advisable, secret mines could be placed along $C'C''$ which, while too low to be reached by a fire from without over the crest of the gun works, would throw all the sand along AB on an assaulting column in middle ditch without affecting seriously the strength of the main works. Of course, these mines would be sprung from bomb proofs, and would be of just enough force to move AB without affecting the rest of main works.

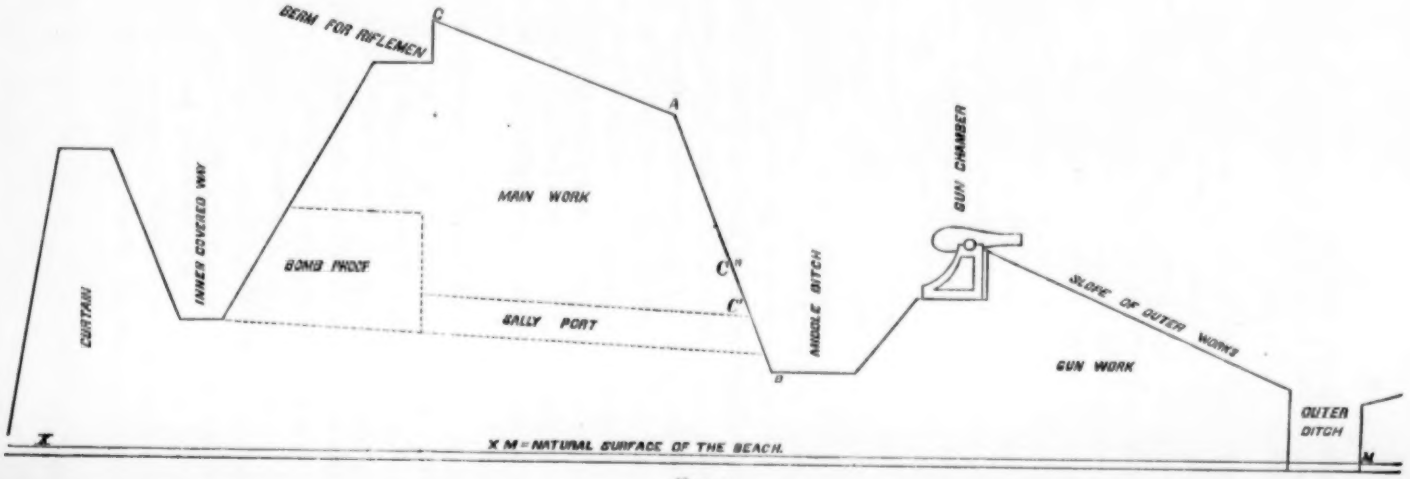

BERM FOR RIFLEMEN
C
A
MAIN WORK
INNER COVERED WAY
CURTAIN
BOMB PROOF
C''
C'
SALLY PORT
MIDDLE DITCH
B
GUN CHAMBER
SLOPE OF OUTER WORKS
GUN WORK
OUTER DITCH
M
X
X M = NATURAL SURFACE OF THE BEACH.

FIG. 3.

One great disadvantage seacoast defenses labor under is that the enemy can fill the works with smoke from bursting shell. At Fort Fisher the smoke from this source was so dense as to hide the ocean; in fact, nothing could be seen for 50 yards. The only way to obviate this is to scatter the guns—putting them, say, 300 to 400 yards apart. This, of course, would necessitate heavy garrisons.

In erecting works, traverses should be freely used, but they should project very little forward of the crest of the gun works, as every inch advance cuts off the range of the gun without proportionally protecting the chambers. Owing to projecting traverses at Fort Fisher, none of the heavy guns—all of which were on the east front—could be brought to bear upon the main station of the fleet, which was to the NE. of the fort.

The thickness of the main works (from C to A) would have to be determined by experiment. It should be at least once and a half the penetrating range of the heaviest guns; that is, if Krupp can drive a shell 40 feet into a sandbank, CA should be at least 60 feet.

Of course, the plan of the works allows the necessary traverses to prevent flanking fire. They could be placed on the gun parapets, or on the inner works, or on both, according to the necessities arising from the topographical features of the surroundings of the works.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Charles E. Munroe.

No. X.

Among our new exchanges we are pleased to note the *Transactions of the Technical Society of the Pacific Coast*, published in San Francisco, Cal. The society was instituted April, 1884, with Colonel Geo. H. Mendell, U. S. A., as president, and has already entered upon the publication of the second volume of its transactions. Besides other papers of interest, we find several devoted to the subject of explosives. Thus Dr. Fred. H. Jenssen treats of the "Causes of Explosions in the Manufacture of High Explosives," **1**, 200; 1884, and finds that these may, in general, be traced to—1. improper construction and faulty arrangement of the works and machines; 2. carelessness on the part of the workmen; 3. maliciousness. Under the first head, he considers the relative dangers of the two principal processes, Nobel's and Mowbray's, for the manufacture of nitroglycerin. He employs in his own practice two Nobel apparatus, having a productive capacity of one ton, built side by side. By this means, three men can run the works and produce six to eight tons of nitroglycerin daily, while a few laborers are engaged on outside work. After the danger of firing in the converter, comes that from overheating when the nitroglycerin is precipitated. As the acid nitroglycerin is very sensitive and decomposes at 100° F., it is essential that the charge in the converter should be run into a very large body of water, and that this water should be changed as soon as possible. Under no circumstances should acid nitroglycerin be stored over-night. Care should be taken that the pipe lines between

*As it is proposed to continue these Notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications or trade circulars.

the tanks do not cross or approach near steam or hot-water pipes. Accidents arise from the wash waters, since they carry nitroglycerin partly in suspension and partly attached to the solid impurities in the water. For economy's sake, as well as to avoid accidents, arrangements should be made to catch as much of this as possible before discharging the water; but where the water is run off, it should be led through earthenware or lead pipe by the shortest line to the river, bay or well. If wooden conduits are used, they become saturated with nitroglycerin and acids. Hence they should be well covered to protect them from the sun, which causes decomposition. The effect of the sun's rays was seen at one factory where no provision had been made to catch the traces of nitroglycerin, and where the wash waters ran a short distance over a sandy beach before entering the river. The result was that on a hot summer's day red fumes were observed rising from the ground, and a heavy explosion soon occurred. Even where wells are used, there is danger from these wash waters. For instance, at a factory where these waters were led through a ditch in rocky ground, it was found that considerable quantities of the explosive had accumulated in the fissures in the rock. Numerous unsuccessful efforts were made to remove this, and finally the ditch was dammed, so as to keep the explosive covered with water. Several years after, the ditch was struck by lightning, and an explosion ensued which damaged the buildings in the vicinity severely and hurled large masses of the rock to considerable distances. From the sensitive nature of acid nitroglycerin, it naturally follows that the recovery of the spent acids is attended with great danger.

In the making of the dynamite, there is little danger if the absorbent is itself a safe one, and is not too warm, and the proper precautions regarding the use of metal tools are taken. The buildings should be heated by hot water or steam, and the pipes so covered as to prevent the dust from settling upon them, or, if it does settle, they should be frequently cleaned. This dust is a constant source of danger, especially in the making of explosive gelatine, where nitro-cellulose is used in the dry state and finely pulverized. In all the rooms, the windows should be shaded to prevent the direct sunlight from falling on the explosive. Similar precautions are to be taken in the packing department; and here the author describes the devices which may be safely used.

The last two causes are discussed at length, and among instances

of maliciousness, the writer cites one from his own experience where a quantity of tips from phosphorus matches were placed in a bag of infusorial earth, and were not discovered until the earth had been made up into dynamite. The essay is a practical one, by a man of many years' experience, and deserves more space than we can give it. It was followed by a discussion, which is printed in the *Trans.* **2,** 16; 1886.

"A Talk about Explosives," by Wm. R. Quinan, **2,** 109; 1886, gives a brief historical survey of the development of gunpowder, and of the growth of the explosive industry on the Pacific Coast; it then describes various explosive compounds and mixtures, and discusses their mode of action and efficiency, and concludes with a résumé of portions of Berthelot's thermo-chemical researches, and of Debus'* paper on the chemical theory of gunpowder.

The most novel among these essays is that by L. J. Le Conte, **2,** 223; 1885, bearing the title "Are Not Dynamite Catastrophes Intimately Associated with Electric Phenomena?" The author has for the past ten years noted the circumstances attending the accidental explosions which so frequently occur on the Pacific Coast, and he has found that, with the exception of such explosions as occur during thunderstorms, these explosions take place during the violent, desiccating north-wind storms peculiar to the winter and spring months in California, but occasionally happening in midsummer. These winds have a velocity of fifty miles per hour, and a relative humidity of about 20 per cent., but frequently as low as 15 per cent., though seldom as low as 5 per cent. During the prevalence of these winds a prodigious amount of electricity is developed by the friction of clothing, especially when walking against the wind. One can thus easily generate a spark *half an inch long*. The phenomenon is also strongly marked in horses at work, the electricity causing their manes and tails to bristle to a remarkable extent. The author finds in this electricity the exciting cause of these explosions, and in the *dust* that prevails in the works, the medium through which explosion is propagated, a dust explosion always preceding the explosion of the mass of powder. These explosions occur on the third or fourth day of the storm. To test his theory, the author made four predictions in 1882 and 1883, and in each case an explosion of considerable magni-

* Proc. Nav. Inst. 9, 1, 1883.

tude occurred. To guard against these accidents, the author suggests the use of steam jets, such as have been so successfully applied in cotton and flour mills and in coal mines.

The author believes that explosions during thunderstorms are caused by the *return shock*, and hence he considers it a fundamental precaution that all good conductors of electricity should be prohibited from entering any building where explosives are stored or manufactured, and believes it would be a wholesome rule not to allow such conductors to be anywhere near the premises.

M. Hay and O. Masson have studied the "Elementary Composition of Nitroglycerol"—*Proc. Roy. Soc. Edin.* **32,** 87. After reference to former work on nitroglycerol by Williamson and others, the authors detail their process for preparing the compound. One part by weight of pure glycerol was added drop by drop to 2 parts nitric acid (1.49) and 6 parts sulphuric acid (sp. gr. 1.84), the two being kept below 10°. After ten minutes the mixture was thrown into water, and the precipitated oil was well washed and dried at 60–80°, finally being kept in a vacuum for twelve days over sulphuric acid, sp. gr. at $14.5° = 1.601$. The combustion was made by weighing out 0.2—0.4 gram into a porcelain boat containing fine copper oxide, and then adding another layer of the oxide. After the boat had been introduced into the combustion tube, its contents were thoroughly mixed with the oxide in the tube; then the combustion was proceeded with in the ordinary way. Nitrogen determinations were 18.25 and 18.06 (theory 18.5). Difference in preparation does not cause a difference in composition. From these results and those obtained by Hay (next abstract), the authors conclude that the generally accepted constitution of trinitroglycerol is correct.

M. Hay gives in the *Trans. Roy. Soc. Edin.* **32,** 67, the results of his study of the "Chemistry of Nitroglycerol." From the resemblance of nitroglycerol to the nitrites in its physiological and therapeutical properties, the author was at first inclined to regard it as being a glyceryl nitrite instead of a nitrate, but the result of a further investigation did not confirm this view. Railton and others have stated that nitroglycerol when treated with alcoholic potash yields glycerol and potassium nitrate. The statement is incorrect: the decomposition is of a complex nature. No glycerol is obtained, as it is oxidized at the expense of the NO_3 groups, about two-thirds of which suffer

reduction to the nitrous condition, only about one-third being found as nitrate at the end of the reaction. The other products of the reaction are potassium acetate, oxalate and formate, a small amount of ammonia, and a reddish-brown resinous substance, which gives a dark color to the liquid. Numerous determinations of the amount of nitrite formed showed that 100 parts of nitroglycerol gave from 34.14 to 35.24 parts of nitrous anhydride. (If two-thirds of the nitrogen were converted into nitrous anhydride, the amount would be 33.48.) As it was also found that 5 mols. of potash were required to decompose 1 mol. of nitroglycerol, it seems that the principal reaction may be expressed by the equation

$$C_3H_5(O.NO_2)_3 + 5KOH = KNO_3 + 2KNO_2 + CH_3.COOK + H.COOK + 3H_2O.$$

The reaction is the same with either alcoholic or aqueous potash, but it is very slow in the latter case, owing to the sparing solubility of nitroglycerol in water.

Ammonia and alkaline carbonates act in a manner similar to potash. The same may be said for sodium hydrogen phosphate, but the reaction is much less powerful, whilst sodium chloride exerts hardly any action. Hydrochloric acid acts less powerfully than alkaline carbonates, and sulphuric acid (1:10) less powerfully still, whilst the concentrated acid has no action. De Vrij's statement that nitroglycerol is decomposed by sulphuretted hydrogen is not correct. The alkaline sulphides decompose nitroglycerol, sulphur being precipitated, and the reaction is rapid, and seems to be promoted by the sulphur; yet the particular part played by that element has not been ascertained. Hot water decomposes nitroglycerol slowly. The amount of glycerol formed from a given weight of glycerol agrees fairly with the assumption of its being glyceryl trinitrate.

As different statements have been made as to the physical characters of nitroglycerol, the author has prepared it in a state of purity, and finds that it is perfectly colorless, and remains so even when exposed to air. It keeps equally well in water or alcohol. Heated on the water-bath, no change occurs unless acids or alkalis are present.

1 gram of nitroglycerol dissolves in 800 cm. of water; in 10.5 cm. alcohol (sp. gr. 0.846); in 1 cm. methyl alcohol (sp. gr. 0.814); in 4 cm. methylated spirits (sp. gr. 0.830); in 18 cm. amyl alcohol; in less than 1 cm. benzene; in 120 cm. carbon bisulphide; in all proportions in ether, chloroform, glacial acetic acid and phenol, and sparingly in glycerol.

Nitroglycerol can be estimated with tolerable accuracy by determining the amount of nitrite formed by boiling with alcoholic potash, and assuming that 100 parts of nitroglycerol yield 33.48 parts of nitrous anhydride. (Abst. *Jour. Chem. Soc.* p. 742, *July*, 1885.)

The "Physiological Action of Nitroglycerol" has been studied by M. Hay (*Chem. Centr.* 108, 1884), and he states that the poisonous action of nitroglycerol cannot be explained by the action of its constituents. The symptoms are similar to those produced by amyl and potassium nitrites. The author found that, of the three NO_3 groups present in nitroglycerol, only one is removed by the action of alkalis as nitrate, the other two combining with the alkali as nitrite, whilst the oxygen set free oxidizes the regenerated glycerol. An alcoholic nitroglycerol solution reacts rapidly in this sense with an alcoholic sodium hydroxide solution, with development of much heat. The formation of nitrite, however, occurs even on digesting at 40° an aqueous solution of nitroglycerol (1 : 800) with a little sodium hydroxide (0.2 per cent.), the reaction being complete in about ten minutes.

Blood at the temperature of the body acts similarly upon nitroglycerol: the blood becomes chocolate-colored, as is the case when it is exposed to the action of amyl or potassium nitrite. Spectroscopic observation reveals the metahaemoglobin band. Reducing agents reproduce the red color of haemoglobin, as in the case of the nitrites above mentioned. Hence nitroglycerol acts by its conversion into nitrite. (Abst. *Jour. Chem. Soc.* p. 681, *June*, 1885.)

In the course of their researches on the heat-relations of the explosion of gaseous mixtures (*Ann. Chim. Phys.* 4 [6], 66, *Jan.*, 1885), Berthelot and Vieille have been able to obtain the specific heat of the elementary gases at high temperatures. The experimental data were obtained by the combustion of cyanogen mixed with sufficient oxygen to convert it into carbon monoxide and nitrogen—two gases which have sensibly the same specific heat. From the pressure developed in the explosion, the temperature referred to the air thermometer was calculated; and from the total quantity of heat produced, and the temperature, the specific heat (at constant volume) of the resulting gaseous mixture was derived, and hence the specific heat of either of the resulting gases. The results of six experiments of this sort were as follows:

Mixtures.	Pressure developed atm.	Heat evolved.	Temperature.	Specific Heat. Total.	For N_2 and CO.
$C_2N_2 + O_2$	25.11	126,500 cal.	4394°	28.81	9.60
$C_2N_2 + O_2 + 1\frac{1}{2}N_2$	20.67	126,500	4024	31.46	8.39
$C_2N_2 + O_2 + 2N_2$	15.26	126,500	3191	39.67	7.93
$C_2N_2 + O_2 + \frac{79}{21}N_2$	11.78	126,500	2810	45.05	6.67
$C_2N_2 + 2NO$	23.34	169,800	4309	39.39	9.85
$C_2N_2 + 2N_2O$	26.02	168,400	3993	42.17	8.43

It will be noticed that the numbers obtained are closely identical, whether oxygen, nitrogen monoxide or dioxide, is used to effect the combustion; thus, at 4400° the specific heat with oxygen is 9.60 and with nitrogen dioxide 9.85, the ratio of N to CO being 1 : 1 by volume. At 4000°, with oxygen, the specific heat was found to be 8.39, and with nitrogen monoxide 8.43, the ratio of N to CO being 3 : 2 by volume. Moreover, it will be observed that the specific heat increases rapidly with the temperature. This increase may be expressed as a function of the temperature by the empirical formula

$$C = 6.7 + 0.0016\,(T - 2800),$$

giving the following calculated values: at 2800°, 6.7; 3200°, 7.3; 4000°, 8.6, and 4400°, 9.3, the observed numbers being 6.7, 7.9, 8.4 and 9.6 respectively. These numbers may be adopted as expressing, at high temperatures and constant volume, the molecular specific heat of the simple gases N_2, H_2 and O_2, as well as of the compound gas CO, which is closely related to them. It is therefore evident that in passing from 0° to 4500° the mean specific heat of the elementary and simple gases nearly doubles. There is, however, another group of elementary and of compound gases to be considered. Regnault showed that the specific heat of chlorine, bromine and iodine was higher than that of the other elements, being 6.6 at constant volume, instead of 4.8. The remarkable fact is that this specific heat is closely the same as that of the compound gases which are formed with a contraction of one-third in volume, as water, nitrogen monoxide and carbon dioxide. The data were obtained by combining chlorine and hydrogen in presence of an excess of one or the other of these gases; from which it appeared that the weight $\frac{3}{2}Cl$ was sensibly equal to that of H_2. The mean specific heat of chlorine at constant volume was found to be at 1800°, nearly three times that of hydrogen, the latter being 5.1, and the former 15.3, nearly. Chlorine comports itself toward oxygen as ozone would do if it were stable and were formed with the evolution of heat.

In a second paper (*loc. cit.* 77), these authors have given the results of similar calculations to determine the mean molecular specific heat of water and of carbon dioxide at high temperatures. The hydrogen was burned either with oxygen alone or with oxygen mixed with nitrogen; in the latter case, the specific heat of the nitrogen was subtracted. The following data were thus obtained:

Mixture.	T.	Total Specific Heat.	Specific Heat of the N.	Mean Molecular Specific Heat of H_2O between 0° and T°.
$H_2 + O$	3240°	18.12		18.12
$H_2 + O + \frac{1}{2} N$	2860	20.52	1.69	18.83
$H_2 + O + N_2$	2543	23.08	6.26	16.82
$H_2 + O + 2N_2$	2180	26.93	11.36	15.57
$H_2 + O + 3N_2$	1798	32.05	15.21	16.84
$H_2 + N_2O$	3133	25.09	7.20	17.89
$H_2 + N_2O + N_2$	2601	30.60	12.70	17.90

The value given in the fifth experiment is not regarded as reliable as the others, since the large amount of inert gas present caused the combustion to be twelve times as slow. It will be observed that here also the specific heat increases with the temperature. The authors represent this increase by the empirical formula

$$C = 16.2 + 0.0019\ (T - 2000).$$

Since the mean specific heat of water-vapor between 130° and 230° is 6.65 at constant volume, it appears that it is more than doubled at 2000°, and tripled at 4000°. On comparing the elementary specific heat of the vapor of water with that of its constituent elements, it appears that the former value is in excess of the latter at 2000° by 7.0, and at 4000° by 5.1. This excess represents a double work—first, that of the molecular disaggregation of the compound gas, and secondly that of its chemical dissociation. The values obtained for carbon dioxide are given as follows:

Mixture.	T.	Total Specific Heat.	Specific Heat of the N.	Specific Heat of the CO_2.
$CO + O$	3334°	20.40		20.40
$CO + O + N$	2840	24.02	3.36	20.66
$CO + O + N_2$	2548	26.69	6.27	20.42
$CO + O + N_3$	1807	37.47	12.67	24.80
$C_2N_2 + O_4$	4862	54.00	10.00	22.00
$C_2N_2 + O_4 + N_2$	4082	64.31	17.50	23.40
$C_2N_2 + 4N_2O$	3972	86.71	42.70	22.00

The fourth of these results is inaccurate, owing to the extreme slowness of the combustion. The results with CO give a mean value of 20.5 between 0° and 2900°; those with CN give 22.5 between 0° and 4300°. Taking them together, they may be represented by the empirical formula

$$C = 19.1 + 0.0015(T - 2000).$$

This gives for the elementary specific heat of carbon dioxide at 2000°, 19.1; at 3000°, 22.1, and at 4000°, 25.1. The mean specific heat of this gas, therefore, more than triples, and the elementary specific heat quadruples, between 0° and 4300°. (Abst. *Am. Jour. Sci.* **29**, 331; 1885.)

Two difficulties attend the determination of the heat of combustion of carbon and its compounds: one arises from the length of time required, the other from the incompleteness of its oxidation. Berthelot and Vieille have obviated these difficulties by effecting the combustion in oxygen compressed to about seven atmospheres, in a calorimetric bomb; using a weight of combustible such that the oxygen consumed by it does not exceed 30 to 40 per cent. of the whole quantity. The ignition is accomplished by a platinum wire heated to redness by electricity, and is completed in a few seconds, sometimes with the characteristic noise given by an explosion in a closed vessel. The entire operation does not require more than three or four minutes, and is applicable to all substances whose vapor tension at the ordinary temperature is inconsiderable. The completeness of the combustion was verified by an examination of the products. The heat of combustion thus obtained is, of course, the heat at constant volume. For carbon this is the same value as that at constant pressure, since the carbon dioxide formed replaces the oxygen volume for volume. For hydrogen compounds, however, the usual corrections are necessary for the condensation of the water-vapor. When cellulose in the form of cotton was burned in this way, the ash being deducted, one gram gave 4.2 calories; or one equivalent (162 grams) 680.4 calories. The heat of combustion, calculated at constant pressure, the water being in the liquid state, is 681.8 calories. Comparing this value with that of the carbon contained in the cellulose (referred to diamond), 564 calories, it appears that that of the cellulose is in the excess 117.8 calories, or about one-fifth. It follows from this that the hydrates of carbon, so-called, contain an excess of energy above that given by the carbon and water which their decomposition would

furnish. The authors call attention to the fact that this is also true of incompletely burned charcoal, as, for example, the *charbon roux* used in making gunpowder; and hence that the energy of a sample of gunpowder due to the carbon it contains cannot be accurately calculated from its percentage composition. (*Bull. Soc. Ch.* **43** [2] 262, *Mar.*, 1885; Abst. *Am. J. Sci.* **30** [3,] 154; 1885.)

In order to determine the rate of transmission of the explosive wave in solid and liquid explosives, Berthelot (*Compt. rend.* **100**, 314; 1885) detonated them in tubes of lead, tin or Britannia metal, 1–2 mm. in internal diameter and 100 to 200 metres long. The explosives employed were pulverulent or granulated gun-cotton, xyloidin, nitromannitol, nitroglycerol, dynamite and panclastite. The results show that as a rule the rate of propagation of the explosive wave increases with the density of loading, and also, for tubes of the diameters employed, with the diameter of the tube. It also seems to increase with the resistance of the material of which the tube is composed. The detonation shatters the tube in which the explosive is contained, and in this respect the experiments differ from those in which the explosives are gaseous. The results were sensibly the same whether the tubes were bent or straight.

With compressed pulverulent gun-cotton, the mean velocity of the explosive wave is about 5200 m. per second in lead tubes, and about 6000 m. per second in tin tubes. Granulated gun-cotton with a density of 1.1–1.3 gave a velocity of about 5000 m. Xyloidin gave similar results. Nitromannitol gives a still higher velocity, granulated nitromannitol of density 1.9 giving the highest observed velocity, 7686 m. per second. With nitroglycerol in tubes 3 mm. diameter the rate of transmission is lower, and varies between 1078 and 1386 m., according to the conditions. Dynamite in tubes 3 mm. in diameter gave a velocity of 2333–2753 m., and in tubes 6 mm. diameter an average of 2668 m. Panclastite gave results similar to those obtained with gun-cotton.

Berthelot finds (*Compt. rend.* **100,** 1326; 1885) that when gunpowder is dried by stoving, in the usual way, at 60°–65°, a peculiar odor is obtained. This smell is due to the sublimation of sulphur, which also carries with it small quantities of the non-volatile constituents of gunpowder. A quantity of the sublimate condensed and collected on plates of glass had the composition: sulphur 97.84,

potassium nitrate 0.90, charcoal, etc., 1.26 = 100. The vapor tension corresponding to this sublimation is too small to be measured.

Among other substances produced by P. Griess in his researches on the "Diazo Compounds," are azonitromethanebenzoic acid, $COOH.C_6H_4.N_2.CH_2.NO_2$, and azoacetoaceticbenzoic acid, $COOH.C_6H_4.N_2.CHAc.COOH$. The former is obtained by mixing an aqueous solution of pure metadiazobenzoic acid nitrate with a dilute solution of nitromethane in an excess of potash, and after a short time adding hydrochloric acid, when the pure acid is thrown down as a yellowish-red precipitate. It is moderately soluble in boiling alcohol and ether; very sparingly in boiling water; is almost tasteless, and detonates when heated. Its ammoniacal solution gives a deep red-colored precipitate with silver nitrate, and no precipitate with barium chloride.

The second compound is formed by the action of metadiazobenzoic acid sulphate on ethyl acetoacetate. It is almost insoluble in boiling water, readily soluble in hot alcohol, from which it crystallizes in small scales or needles which have a bitter taste. When cautiously heated it melts, and at a higher temperature detonates, leaving a carbonaceous residue. The silver salt forms a bright yellow, amorphous precipitate. (*Berich. Berl. Chem. Ges.* **18,** 960; 1885.)

A. Smolka states (*Monatsch. Chem.* **6,** 198) that when ammonia is added to an aqueous solution containing lead nitrate and mannitol in the proportion of 2 mols. of the former to not less than 1 mol. of the latter, a mannitol lead nitrate having the composition $C_6H_8O_6Pb_4(NO_3)_8$ is precipitated. This substance is sparingly soluble in water and insoluble in alcohol. It detonates when suddenly heated. The nitric acid in the compound is not eliminated by treatment with ammonia. (Abst. *Chem. Soc. Jour., July,* 1885.)

In the study of the "Polyacetylene Compounds," A. Baeyer finds (*Berich. Berl. Chem. Ges.* **18,** 674; 1885) that diacetylenedicarboxylic acid, $COOH.C \vdots C.C \vdots C.COOH$, is obtained by oxidation of the copper compound of ethyl propargylate with an alkaline solution of potassium ferrocyanide. It crystallizes with one mol. H_2O in rhombic tables or needles; it turns brown at 100°, and explodes violently at about 177°. This seems to be the first instance of an explosive substance containing carbon, hydrogen and oxygen only. On

exposure to light, the acid at first assumes a deep rose color; on longer exposure it is converted into a purple-red mass. It is readily soluble in ether, alcohol and chloroform, moderately in water, very sparingly in light petroleum and benzene. With an ammoniacal copper solution, the aqueous solution gives a brownish-red precipitate; with silver nitrate, a white turbidity. In a subsequent paper (*loc. cit.* **18,** 2269; 1885) the author finds that a better yield of the diacetylenedicarboxylic acid is obtained if free propargylic acid is employed for its preparation, instead of the ethyl salt.

The alkaline copper compound yields tetracetyleneolicarboxylic acid, COOH.C ⋮ C.C ⋮ C.C ⋮ C.C ⋮ C.COOH, when oxidized with potassium ferrocyanide. This forms fine, colorless needles which blacken quickly even when protected from light. It is extremely explosive, and yields sebacic acid when reduced.

By warming ammonium diacetylenedicarboxylate with cuprous chloride at 30°, a reddish-violet precipitate of the copper compound of diacetylene is formed, and this, when heated with a concentrated solution of potassium cyanide, yields a gas which has an odor somewhat like dipropargyl, and which, when passed through an ammoniacal solution of cuprous chloride, again yields the reddish-violet precipitate. With an ammoniacal silver solution, it forms a yellow precipitate which is exceedingly explosive, exploding even when rubbed in the wet state between the fingers.

Diiododiacetylene CI ⋮ C.C ⋮ CI is obtained by treating the silver diacetylene compound under water with a solution of iodine in aqueous potassium iodide. It forms colorless crystals and melts at 101°; it smells like iodoform, and when heated in tubes explodes violently with a flash of red light. If kept for some time exposed to the light it is polymerized, forming a brown, crystalline mass which detonates on heating.

Among other "Intermediate Reduction-Products of the Nitroazo Compounds," J. V. Janovsky and L. Erb (*Berich. Berl. Chem. Gesel.* **18,** 1133; 1885) have obtained the trinitroazobenzene by nitrating either mono- or diparanitrazobenzene or azobenzene with fuming nitric acid. It may be crystallized from acetone or alcohol, and is obtained in long sulphur-yellow needles. It melts at 169° to a red fluid, which explodes when heated above its melting-point.

Among the processes used for the production of metallic potassium is that in which an intimate mixture of potassium carbonate and

charcoal is heated in an iron retort. Through the action of the heat a reaction takes place from which carbon monoxide and potassium result. Unfortunately, however, a secondary reaction also occurs, through which a black compound is formed which detonates violently upon the slightest friction. If the potassium be not pure, this compound is readily formed when the metal is exposed to the air, or even when immersed in naphtha.

Liebig was the first to observe (*Ann. Ch. Pharm.* **11**, 182) that metallic potassium united with carbon monoxide. According to Brodie (*Chem. Soc. Qu. J.* **12**, 269; 1859), pure potassium heated to about 80° in carbon monoxide free from air, is at first slowly converted into a dull gray, crystalline substance, ($K_2C_2O_2$); but if the passage of the gas be continued, a more rapid absorption takes place even at a lower temperature, and the gray crystals are converted into a dark red compound $K_2C_2O_3$. This dark red carbonyl may be preserved under mineral naphtha, but is decomposed with extreme violence by water, and even in the dry state sometimes explodes from causes which have not been made out. When anhydrous alcohol is added to this red compound, it is partly dissolved and partly converted into potassium oxide and potassium rhodizonate. Hence the carbonyl may be regarded as a basic potassium rhodizonate.

The black explosive substance formed in the manufacture of potassium appears to consist of one or both of the compounds just described. According to Kühneman (*Jahresb.* 180; 1864), when potassium is intensely heated in carbon monoxide gas, there are formed, first, a gray mixture of potassium oxide and free carbon, which separates as the apparatus cools from a white to a red heat; and secondly, a dark red body, which separates at a temperature below dull redness, both compounds being formed without access of water or moist air. On collecting these separately, the red substance was found to dissolve in water, forming a solution which exhibited all the reactions for potassium rhodizonate. The gray mass was explosive, and Kühneman attributes this either to the heating of the mass through absorption of water, or to the formation of potassium peroxide (from the protoxide present) and its action on the free carbon.

The name rhodizonic appears to have been applied to two different acids, produced under different circumstances from potassium carbonyl. Berzelius and Wöhler noticed that a red substance is produced by the action of water on the black mass formed in the preparation of potassium by Brunner's process. L. Gmelin found

that the aqueous solution of this substance yields potassium croconate when evaporated in contact with the air, and inferred that it contains an acid different from croconic acid. Heller (*Ann. Ch. Pharm.* **24**, 1; 1837) examined this acid more particularly, and gave it the name of rhodizonic acid. It was further examined by Werner (*J. Pr. Chem.* **13**, 404), but the experiments of these chemists did not determine the composition of the acid. Brodie regarded his acid ($C_{10}H_8O_8$) obtained as above described as identical with that previously obtained by Heller and Werner. On the other hand, Will (*Ann. Ch. Pharm.* **118**, 187; 1861), by the analysis of several salts of the acid, obtained in a similar manner to that of Brodie's, but from the impure potassium carbonyl formed in the preparation of the metal, concluded that its composition is $C_{10}H_8O_{12}$ or $C_5H_4O_6$, and this result is confirmed by Lerch (*Ann. Ch. Pharm.* **124**, 20), who has obtained rhodizonic acid in the free state by decomposing the salts of carboxylic acid, $C_{10}H_4O_{10}$, with acids. The acid obtained by Heller and analyzed by Will and Lerch is styled the α-rhodizonic, and that obtained by Brodie the β-rhodizonic acid.

In the experiments of Lerch, he found that if perfectly unaltered potassium carbonyl, to which Brodie assigns the formula $C_6K_2O_6$, be treated with hydrochloric acid, it yields trihydrocarboxylic acid, $C_{10}H_{10}O_{10}$, which crystallizes in white needles. If the carbonyl be first treated with alcohol and then with hydrochloric acid, it yields black needles of dihydrocarboxylic acid, $C_{10}H_8O_{10}$. If the air has had access to the mass before or after the treatment with alcohol, it afterwards yields, with hydrochloric acid, dark, garnet-red crystals of hydrocarboxylic acid, $C_{10}H_6O_{10}$. Lastly, if the mass has been left in contact with the air till it has turned quite red, and it is then treated with hydrochloric acid, a fourth acid is obtained called carboxylic acid, the potassium salts of which have the formulas $C_{10}HK_3O_{10}$ and $C_{10}K_4O_{10}$. On attempting to isolate this acid, rhodizonic acid is obtained.

Nietzké and Benckiser have repeated Lerch's experiments (*Ber. Berl. Chem. Ges.* **18**, 1833; *July*, 1885), and have proved that his trihydrocarboxylic, dihydrocarboxylic and carboxylic acids are identical with the hexaoxybenzene, tetraoxyquinone and dioxydiquinoylbenzene, respectively, already described by them. The carbonyl-potassium was obtained by passing a current of CO, completely dried and freed from oxygen, over potassium heated to melting in a combustion tube. At the close of the experiment the

potassium had gained in weight about 70 per cent.; confirming Brodie's view that one molecule of CO was absorbed for each atom of K. The product was a solid, grayish mass, with here and there patches of a red-brown, green or black color. After cooling, the tube may be filled with strong alcohol without danger of explosion. On treating the crude product with hydrochloric acid, hexaoxybenzene $C_6(OH)_6$ is produced, which proves that the carbonyl-potassium is most probably $C_6(OK)_6$ or potassium-hexaoxybenzene. The former is accompanied, however, by tetraoxyquinone, its first oxidation product, from which it may perhaps be formed during the solution in HCl, by the reducing action of the K still present upon the corresponding potassium compound directly produced: $(CO)_6 + K_6 = C_6(OK)_4O_2$. To ascertain this, the freshly prepared carbonyl-potassium was dissolved in acetic oxide and precipitated by water. The brown precipitate crystallized from glacial acetic acid gave the characteristic hexacetylhexaoxybenzene. The residue after treating the crude product with alcohol is a dark green powder, which turns red in the air, and which, boiled with HCl, dissolves with a brownish-red color. On cooling, the solution deposits stellate groups of steel-blue needles of tetraoxyquinone $C_6(OH)_4O_2$. If the crude product be washed with dilute alcohol, it turns red, and finally produces an ochre-red powder, the so-called rhodizonic acid. This the authors find to be identical with their dioxydichinoylbenzene $C_6(OH)_2O_4$.

The *Jour. Chem. Soc., Jan.*, 1885, p. 69, contains an account of the further researches* of E. Divers and M. Kawakita of the fulminates, under the title "On the Decomposition of Silver Fulminate by Hydrochloric Acid." The fact has already been noted by them that silver fulminate differs from mercury fulminate in yielding much less than the full amount of hydroxyammonium chloride, and in yielding ammonium chloride. Besides, the silver fulminate is energetically attacked by concentrated HCl. If the heating is not checked, the silver chloride produced is at first stained orange, but rapidly loses its color, imparting it to the acid mother-liquor, and it disappears from this during the subsequent evaporation. In addition, there is at first, among the products of the reaction, an unstable, colorless substance which gives an intense wine-red color with $[Fe_2]Cl_6$, either in the acid or neutral solution. Long standing in the cold, or a few

* Proc. U. S. Nav. Inst. 11, 100; 1885.

minutes' heating, deprives the solution of this power. The only gases liberated by the HCl are CO_2 and HCN. The total nitrogen of the silver fulminate being 9.33 per cent., they obtained

Nitrogen as hydroxyammonium	6.95 per cent.
" " ammonia	1.50
" " hydrogen cyanide	0.18
" unaccounted for	0.70
Total	9.33

It is tolerably certain that some ammonia escapes unmeasured. Though Steiner's experiments have been repeated again, using ether in place of water as a menstruum, no oxalic acid was obtained by decomposing mercury fulminate with hydrogen sulphide.

The results show that no difference exists between the silver and mercury salts as fulminates, what difference they show being caused by the metallic radicals. The same hydrolysis occurs with both; but in the case of the silver salt, in consequence probably of the sharp separation of the AgCl in the solid state, the decomposition generates heat so rapidly that the formic acid and hydroxyammonium chloride change into CO_2 and NH_4Cl, thus:

$$C_2Ag_2N_2O_2 + 4HCl + 4OH_2 = 2CH_2O_2 + 2NH_4OCl + 2AgCl$$
$$\text{and } CH_2O_2 + NH_4OCl = C_2O_2 + NH_4Cl + H_2O.$$

In a paper "On the Constitution of the Fulminates," same journal, p. 77, E. Divers defends the formula $H\overline{C\overline{NONC}}OH$, advanced by him,* though he accepts $H\overline{C\overline{NOC}}(NOH)$ as equally satisfactory. Yet an argument in favor of the former is that it shows the hydroxyl in union with nitrogenized carbon, and, therefore, as in cyanic acid, markedly basic, while in the latter the hydroxyl of an hydroxylamine derivative is represented not only as basic, but as capable of taking part without difficulty in double decompositions in water and yielding the various bimetallic fulminates, notwithstanding that the hydroxyl of hydroxylamine has been found analogous to "alcoholic" hydroxyl in carbon compounds, its hydrogen being replaceable by organic radicals only, and not by metals, in presence of water, if at all. Schramm's hydroxylamine compounds, containing Ag or Na, may or

* Proc. U. S. Nav. Inst. 11, 103; 1885.

may not be metaloxyl-derivatives. The Na compound appears unable to exist in water. The radical :N.O.N: has the support of Goldschmidt, who used it in representing the possible constitution of a dioximido-derivative of phenanthraquinone. Divers dissents from the latter part of Armstrong's theory that, in the conversion of alcohol into fulminate, hydroxyethaldehydrol is first formed and then acted on half by hydroxylamine and half by nitrous acid, since these two latter bodies cannot act without mutual destruction, or destruction of each other's derivatives.

Armstrong replies to this that it is possible and probable that the latter bodies may exist side by side if a third body is present with which one or both may enter into reaction, or which tends to exercise a protective influence. Divers' own observations on the action of tin on a mixture of HNO_3 and HCl may be cited in support of this view. Armstrong is inclined to regard $N<\begin{matrix}C.OH\\ \cdot\\ C(N.OH)\end{matrix}$ or $\begin{matrix}N.CH\\ \cdot\ \cdot\\ O.C(N.OH)\end{matrix}$ as the most probable formulas for fulminic acid, and that they take into account both the elimination of the two nitrogen-atoms as hydroxylamine and also the formation of bimetallic fulminates; but he does not regard them as final. He also points out that, although the fulminates have hitherto been regarded as "dicarbon" derivatives, on account of their formation from ethyl alcohol, there is no direct evidence to support the view; and it is noteworthy that Divers has always failed to obtain oxalic acid by their hydrolysis.

Dingl. Polyt. Jour. **255**, 337; 1885, describes the following novelties in explosives: For the production of gunpowder containing carbon, J. Nordenfelt and F. A. Memling propose to prepare a carbonaceous substance from cotton, woody fibres or similar substances, by treating them in a loose form with hydrochloric-acid gas, whereby the fibre is converted into a brittle substance.* This is thoroughly mixed with the proper amount of a saturated solution of sulphur in carbon bisulphide in a closed vessel provided with a mechanical agitator. The dry mixture of carbon and sulphur is saturated with an aqueous solution of potassium nitrate, and the water evaporated off at a gentle heat. The powder is then finished according to the usual method.

F. W. Gilles proposes to manufacture explosive compounds by

* Proc. U. S. Nav. Inst. **8**, 309; 1882.

treating molasses with a mixture of nitric and sulphuric acids. He obtains the explosive in two forms, which he calls solid and liquid nitro-molasses. In both cases 380 grams molasses, 1000 grams fuming nitric acid, and 2000 grams concentrated sulphuric acid, are mixed together. The product, when washed first with cold, then with warm water, deposits a precipitate of a gray-yellow or whitish color, and can be used at once as an explosive material. To obtain the liquid explosive, the nitro-molasses is brought to a composition corresponding to 34 parts carbon, 54 parts oxygen and 12 parts hydrogen, nitrogen and salts. When the molasses contains less oxygen and carbon than the above proportion, it is treated in open vessels with lead peroxide and carbon bisulphide, and the mixture is allowed to ferment at a temperature not exceeding 130°. The prepared molasses is then nitrated. When the molasses contains less oxygen than the proportion stated above, it is treated by oxygen gas forced into it under pressure in closed vessels. The fluid nitro-molasses, when heated, slowly boils at between 180° and 200°, and detonates between 220° and 250°, and can be mixed with any absorbent.

In the same journal, **254**, 355; 1884, A. Gacon describes a blasting powder made by mixing 69 parts of potassium or sodium nitrate with 19 parts of sulphur, and adding ash (?) rich in potash or soda to the mixture. It is proposed to obtain this ash by burning dead leaves. 200 grams of tannin dissolved in 8 litres of water are then added to the mixture. One kilo. of this powder is said to blow up 12 to 15 cubic metres of rock. It requires a temperature of 480° for its ignition, and cannot be exploded by concussion, not even when hammered on an anvil. (Abst. *Jour. Chem. Soc., Mar.*, 1885.)

In a preliminary note on the "Theory of Explosions" (*Proc. Camb. Phil. Soc.* **5**, 309; 1885), R. Threlfall has made an attempt to account for some of the anomalous effects observed in explosions by Sir Frederick Abel. In the well-known experiments with detonators composed of various explosives, Abel was led to imagine that the apparent selective efficiency of chosen substances, when applied to explode one another, might be accounted for on an hypothesis of "synchronous vibrations." It was pointed out that this hypothesis can have no possible physical meaning, unless the vibrations be supposed to take place in the ether; and an explanation was sought in the behavior of the products of explosion as regards their motion in

air and in water. For this purpose, the explosives were treated in groups arranged with respect to their supposed time of decomposition, and it was shown that much would depend on the method of "break-up" of the volume of gas set free by the explosion. The various ways in which the energy of an explosion might be transmitted through fluids were enumerated, and some stress was laid on the effects to be expected if the conditions of explosion were such as to lead to the production of vortex rings.

The necessity of clearly defining the meaning of the phrase "violence of explosion" was pointed out, and it was shown that the "violence," as defined by $\frac{\text{increase of volume}}{\text{time of explosion}}$, would not represent the relative destructive effects of explosions in free air. Various experimental methods of treating the question of "break-up" were described, and further communication was reserved pending the result of experiments still in progress.

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THE SURVEY OF THE COAST.

By Lieutenant George L. Dyer, U. S. N.

While the officers of the Navy have been watching, with intense interest, the movement to build modern ships and to reorganize the administration of the Navy Department, they have paid little attention to a very important and interesting question which has been the subject of congressional investigation for nearly two years, and is now rapidly nearing a temporary, if not a final, conclusion.

In 1884 Congress appointed a Commission, consisting of three senators and three members, to "consider the present organizations of the .... Coast and Geodetic Survey and the Hydrographic Office of the Navy Department, with a view to secure greater efficiency and economy of administration of the public service in said Bureaus" (p. *1).* This Commission, after sitting for two winters, has now finished taking testimony, and, we are informed by the newspapers, is deliberating what course to pursue.

As many of the officers of the Navy have served in the Coast and Geodetic Survey, and have contributed the greater portion of the work which has continued its existence and sustained its claim to usefulness, and as it is believed that the best interests of the Navy and of the Government will be subserved by its transfer to the Navy Department, it is thought proper to lay before those interested a brief statement of the case as it stands at present.

In order to avoid a confusion of terms, let us notice that the title of this organization is *not* Coast Survey, which naval officers are accustomed to use in speaking of it, and which was its honorable appellation until recently. The act of March 3, 1879 (p. 773), legalized the term *Coast and Geodetic Survey*, thus enabling it to adopt a title indicating functions assumed many years before.

*The pages mentioned refer to the printed "Testimony before a Joint Commission." The italics are generally mine.

In this connection the representatives of the Navy Department have laid great stress on the points that geodesy has nothing to do with a survey of the coast; that geodetic methods applied to land work have absorbed most of the money appropriated for the survey of the coast, and as a result it is not yet surveyed, and no time will be set, without conditions, when the primary survey will be definitely finished.

Commander Bartlett refers to this matter (p. 887) in the following terms:

> The hydrographic work of the Ranger has been of the same character as that done by the naval officers under the direction of the Coast and Geodetic Survey. This is the work which is essential to the construction of a nautical chart. Geodetic refinement of triangulation and elaborate detail of topography have not been attempted, as being entirely foreign to the objects of a nautical survey. Latitudes and longitudes, the variation of the compass, the rise and fall of the tides, have been determined, the positions of the soundings fixed by the aid of triangulation, and such topography delineated as may serve as an aid to navigation.
>
> Mr. Hilgard makes his comments from the standpoint of a geodesist and topographer, to whom a nautical survey is only subordinate and incidental. I speak from the standpoint of a practical navigator and hydrographer, to whom geodesy and topography, at this stage of their development, have only an interest in common with other sciences not materially related to navigation.

The following is a brief outline of the legislative history of the Coast and Geodetic Survey:

In pursuance of the recommendation of President Jefferson (p. 246, Report of Secretary of the Navy, 1882, Vol. I.) to establish a national coast survey "for the purpose of making complete charts of our coast, with adjacent shoals and soundings," Congress passed the act of February 10, 1807, which authorized the survey and made an appropriation for it. This act reads as follows (p. 28): "That the President of the United States shall be, and he is hereby, authorized and requested to cause a survey to be taken of the coasts of the United States in which shall be designated the islands and shoals, with the roads or places of anchorage, within 20 leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes or headlands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coast within the extent aforesaid."

The work was assigned to the Treasury Department, but, owing to the unsettled condition of affairs at that period, nothing was done

until 1817. By the act of April 14, 1818, which contained the proviso that the survey should be conducted only by naval officers, the Coast Survey was discontinued as a separate organization, and, until 1832, surveys were carried on by officers of the Army and Navy, and, from the results, charts of the most important harbors were made.

By the act of July 10, 1832, Congress revived the organization which was assigned to the Treasury Department, although the act expressly stipulated that the President was authorized to "employ all persons in the land or naval service of the United States." In 1834 it was transferred to the Navy Department, and two years later again transferred to the Treasury Department, where it has since remained.

The question of assignment to the Navy Department being constantly agitated, Congress provided for an examination into, and settlement of, the matter by the act of March 3, 1843. This act provided that the survey should be conducted in accordance with a plan, to be submitted by a board consisting of the Superintendent of the Coast Survey, his two principal assistants, two naval officers, and four from among the principal officers of the corps of Topographical Engineers. A glance at the composition of this board—seven landsmen specialists and two sailors—will show at once that it was arranged to exclude entirely the idea of naval control, and it must have been due to a special interposition of Divine Providence that the consideration of hydrography was admitted at all. It is not to be wondered at, therefore, that an elaborate plan for triangulation and topography was recommended, and that the Treasury was suggested as the proper Department to control the work. The plan received the President's approval, and has since formed the basis upon which the survey has been conducted. No mention of the word geodesy, nor any reference to it whatever, is to be found in this plan. It is clear that a geodetic survey was not contemplated, as the science of geodesy was about as well known in 1843 as now. Picard's geodetic work under the French Academy was completed in 1670, and geodetic surveys have been going on continually ever since.

In regard to this plan Commander Bartlett says (pp. 893–894):

> The organization which resulted from this law was bound by the methods prescribed by the board, and, until it had gained experience by actual work, it could not be held responsible for a system which did not attain the results desired within a reasonable time. When, however, it became obvious that the "survey of the coast" would not be completed, it was the imperative duty of this organization to change its methods, either by legislative permission, or by

delaying such portions of the work as did not aid materially in the accomplishment of the special object for which it was created. This was not done. It is only reasonable to assume that its methods never will be changed, except temporarily, under the spur of criticism or investigation, so long as its directors, having little interest relatively in its most important productions, possess only a theoretical or imperfect knowledge of what these charts should represent. This results naturally from a lack of nautical experience.

In 1848, and again in 1849, attempts were made in Congress to transfer the Survey to the Navy Department. In 1850 a resolution of the Senate called on the Secretary of the Navy and on the Secretary of the Treasury to state reasons for and against the transfer. Their replies in 1851 ended the active interference of Congress in the matter for several years, although the agitation for the transfer was continuous to the commencement of the Civil War. After its close, and the subsequent readjustment of affairs, the evident impropriety of leaving this important work under the present management began to assert itself, and finally culminated in the action of Congress already mentioned.

To complete the legislative history of this organization, I will quote from Commander Sigsbee's exhaustive paper in the Report of the Secretary of the Navy for 1882, Vol. I., p. 246:

All acts mentioned in the following list are acts making appropriations for the expenses of the Survey.

The act of March 3, 1853, legalized investigation into the characteristics of the Gulf Stream, involving temperature, deep-sea soundings, and current observations far at sea—a work which should have been done from the outset under cognizance of the Navy Department. The effect of this act was to authorize the Coast Survey to publish "sailing" or off-shore charts.

The act of March 3, 1871, greatly extended the work of the Survey by legalizing the determination of geodetic points in each State of the Union and across the continent. The present title of the Survey—viz.: the *Coast and Geodetic Survey*—was not assumed at once on the passage of this act, but was occasionally heard in 1877, when the transcontinental geodetic work had progressed beyond the stage of probability. This act also legalized a "*development of the dangers of ocean navigation*" between San Diego, Cal., and Panama. Where this work passed the limit of the United States, it should have devolved upon the Navy, according to precedent.

In reference to this act, Superintendent Hilgard says (p. 133, Testimony):

This had underlying the idea of an ultimate trigonometrical survey of the whole area of the country.

The act of March 3, 1875, legalized deep-sea operations throughout the Gulf of Mexico and to an indefinite extent in the Pacific Ocean. A complete deep-sea survey of the Gulf of Mexico followed, lasting for four years. The work was done by naval officers with a Coast Survey vessel. The greater part of the expense, which was for pay of officers and men, came from naval appropriations.

The act of June 20, 1878, legalized the survey of rivers to the head of ship navigation or tidal influences. It also extended the work of the Survey to include deep-sea dredging for animal forms, and widened the field of operations to include a part of the Caribbean Sea. The greater part of the expense was borne by naval appropriations.

The act of March 3, 1879, legalized the title *Coast and Geodetic Survey*, which is borne by the annual report of the Survey for 1878, but not by that for 1877. This act embraces a still wider field of operations for all classes of deep-sea work. Not only is the whole Caribbean Sea included, but also the whole Sargasso Sea in mid-Atlantic Ocean. The Caribbean Sea work was continued as before. A vessel of the Survey was engaged almost exclusively in this class of work for more than seven years. The chief burden of the expense was charged to the naval appropriation.

I have thus fully traced the legislative history of this organization for the purpose of indicating two things—the evidence of unremitting agitation on the part of the Navy to secure the control of what should be a strictly nautical work, and the gradual but certain extension of its operations away from the field which it was especially designed to cover.

In the absence of a continuously definite policy on the part of the Navy Department, the agitation referred to, long since become a tradition of the service, indicates a fundamental error in the composition of the working force, and in the assignment of the administration of this important work.

By reason of this absence of policy, no opposition has been made to the gradual expansion of the jurisdiction of the Coast and Geodetic Survey, until the work on the coast has become entirely subordinated to a great geodetic survey of the interior (p. 869), and the field off the coast is only limited by the shores of those countries which do not permit a stranger to perform their work. Assistant Baker, of the Coast and Geodetic Survey, testifies (p. 633) that "since the creation of the Survey by the act of 1807, the field of the Survey's operations has been gradually extended until it now by law embraces the entire United States and the *waters off the coast to a limit incapable of sharp definition.*"

The organic acts relating to the Coast and Geodetic Survey have

always indicated its manifest purpose. Of late years, however, clauses have been introduced into appropriation bills which, in the absence of a jealous watch on the part of the Navy Department, have gone through Congress unchallenged, and have legalized such works as the system of triangulation along the Appalachians, the transcontinental belt, the furnishing of points in States, and a vast amount of expensive work which no practical seaman or hydrographer will admit to be of value for nautical purposes.

No objection would be made to this were the proper degree of energy and interest taken in that portion of the work which is the support of all the rest—viz.: the hydrography and those littoral operations of triangulation and topography which are essential to it. This has not been the case. The coast of the United States is not yet surveyed, and there are portions of it where any vessel venturing is subject to risks which at this time, nearly eighty years from the commencement of the work, place a degree of culpability on this organization which the maritime community will thoroughly appreciate when it knows the facts.

Commander Bartlett refers to this matter in the following words (pp. 894, 895):

> Had the policy thus outlined been adopted, the primary survey of the coast would have been finished years ago, and the responsibility of leaving portions of it unsurveyed, where lives and cargoes must be hazarded, would not have attached to the Coast Survey. This policy would have been adopted had the direction of this work been placed in the hands of those whose duties at times oblige them to venture into unsurveyed waters, and who have an intimate and personal interest in having it done well and quickly.
>
> Most of the money appropriated has gone into land work which is not essential to the production of charts for the use of navigators. Can it be doubted that the sentiment underlying the yearly grant of money to the Coast Survey has been to facilitate the movement of commerce along our coasts and to preserve the lives of seamen?
>
> The triangulation carried on by this organization has been of the most refined and expensive character. The topography has been executed with the utmost elaboration. The character of its work from a scientific standpoint cannot be assailed. But in the meantime the "survey of the coast" has dragged along, and no time is yet set for its definite completion.
>
> For the reason, then, that the accomplishment of its principal object was being delayed—indirectly, perhaps—this organization assumed a very grave responsibility in not changing its methods long ago.
>
> From the standpoint of the sailor who has to venture into unknown waters, how can the expenditure, by this organization, of millions of money for purposes more or less foreign to a coast survey be justified?

In a letter to the Secretary of the Treasury in 1857 (pp. 251, 252, Report of Secretary of the Navy, 1882, Vol. I.), Superintendent Bache, of the Coast Survey, says: "*In determining the scale and mode of executing the coast survey, it should be considered that the work is a temporary one, having a limited object, the surveying of a definite extent of coast; taking all the operations into consideration, the Atlantic sections are more than half done, the Gulf (of Mexico) sections are nearly one-third done, and both can, at the present rate of appropriation, be completed in from ten to twelve years by close economy and thorough efficiency of arrangement.*"

During the Civil War the organization was kept up and received large appropriations; *twenty-seven years*, therefore, after the expression of this opinion by the greatest authority of the Coast Survey, Superintendent Hilgard, of the Coast and Geodetic Survey (p. 137), says: "The work of the Coast Survey proper on the Atlantic and Gulf coasts requires *four* years to make the surveys continuous, at the present [last year's] rate of appropriations"; and (p. 140): "As to the Pacific coast, exclusive of Alaska . . . I estimate the time required to be about *nine* years, at present [last year's] rate of appropriations."

Commander Chester (p. 453) refers to the completion of the primary survey as "many years distant, under the present appropriations of Congress." *Twenty-eight years* after the expression of Bache's opinion, Assistant Colonna testifies (p. 609): "If Congress appropriates with sufficient generosity, and does not bind the Superintendent too rigorously, a practical Superintendent will, in from *three* to *five* years, complete the original surveys on the Atlantic. . . . The surveys of the Pacific coast can be completed in about twelve years with the remodelled force, and funds enough to conduct the work economically." This means, practically, that the survey of the coast will never be completed as long as its unfinished condition constitutes an argument to draw money from Congress for the prosecution of the great trigonometrical survey of the country and its collateral operations.

No really earnest attempt has been made to complete the survey of the coast, and it is believed that no continued and persistent effort will be made as long as the direction of the work is not in the hands of men who have a lively interest in having it well and speedily done. I think this can be fairly concluded from the record of the past; from the fact that, if the coast is not charted rapidly, no particular responsibility attaches to the Coast and Geodetic Survey, under the super-

vision of a department which has no need for coast charts especially; and finally, from the postulate, that men, trained to land work and interested in the operations of geodesy, topography, leveling, etc., unaccustomed to the sea, without nautical instincts and traditions, cannot, in the nature of things, take any great interest, comparatively, in the making of nautical charts.

The first step taken by the Congressional Commission in the present investigation was to call on the National Academy of Sciences for an opinion. This body promptly replied with a report (pp. *1–*10) which must be considered, under the circumstances, as very favorable to the naval side of the question. The withdrawal of the only member of the committee (p. *1) (appointed by the President of the National Academy) whose opinion in the matter could possibly have more weight than that of any educated gentleman, left it composed entirely of scientists whose specialties are about as far removed from questions relating to the needs of seamen as can be well imagined—for the making of charts for purposes of navigation and commerce constitutes the vital principle of both the Coast and Geodetic Survey and the Hydrographic Office, and it cannot be ignored in any consideration of the relations of these bureaus.

This report naturally advocates the claims of science. It goes so far as to recommend that all scientific branches of the Government be put in one department, in order to give scientific investigations greater unity and success. It might be expected that, recognizing the work of the Hydrographic Office as scientific, the National Academy would think it advisable to group it with the other bureaus. It does not, however, as will be seen by the following. After a very thorough account of the present administration of the Hydrographic Office, the committee says (p. *6): "This work of the Hydrographic Office is evidently of great value and importance to our commercial and business interests, and must save many vessels from wreck and many lives from destruction.

"While this work [that of the Hydrographic Office] is scientific work, your committee is not prepared to recommend that it be detached in any way from the control of the Navy Department." This recommendation, from a body whose tendencies would be almost irresistibly in the other direction, must be considered conclusive.

But the Academy goes further. It states (p. *3): "The hydrographic surveys of the coasts of Europe appear in every country to be the work of the Naval Establishment," and traces the history of the

Coast and Geodetic Survey, showing the gradual advance into fields not originally contemplated. Then follows a practical recommendation to transfer to the Navy Department the direction of the survey of the coast after it has been once accomplished (p. *6):

> Nor can they recommend that the hydrographic work of the Coast Survey, for over forty years conducted so satisfactorily under the civil control of the Coast Survey, be separated from that organization *before the original survey shall be completed. After that is done, perhaps the work of re-sounding, of re-examining may without injury to the service be committed to the control of the Navy Department.* . . . While, therefore, your committee are not prepared at the present time to recommend the proposed consolidation, we do not conceive that Congress should adopt measures looking to the separation in perpetuity of the two branches under consideration. The policy of the Coast Survey should, we conceive, be directed towards the completion at the earliest possible date of the survey of our coast line; its main operations will thereafter be confined principally to the interior, and then the policy of consolidating its hydrography with the work of the Naval Hydrographic Office will be open for consideration.

This conclusion was reached from the considerations contained in a preceding paragraph, which is as follows (p. *6):

> The reasons for the consolidation of these two works under the Navy Department have been urged with force by the Secretary of the Navy in his last two annual reports (1882 and 1883). But there are also cogent reasons on the other side of this question. The Coast Survey was specially organized to secure the harmonious co-operation of civilians, officers of the Navy and officers of the Army, each in his own department and yet in a single, well co-ordinated work. No scientific department of the Government has worked more successfully through the forty years in which this organization has been in operation. Each of the three branches thus harmoniously co-operating has received the benefit of the skill and professional experience of the other.

These are the "cogent reasons" advanced for the recommendation already quoted. It is very evident that the committee made no examination into the details of this important matter. The grave and artless assumption that this is a fact which those interested will accept, with proper deference to the character of the body which utters it, recalls the credulous dignity of Sir Joseph Porter, K. C. B. *There have been no Army officers attached to the Survey since the commencement of the Civil War.* Where is there co-ordination between the remaining bodies, naval officers and civilians, in that most important and expensive branch, the field-work of the Survey? Just how much exists is known to every officer who has been on duty in the Coast Survey, and who has had to climb about in all sorts of places to cut

in his own signals, or who has had to search for triangulation points long since obliterated, or who has had to take the sheets of the topographers and change the scale for his own hydrographic work. This same absurd pretension appears throughout the testimony of the witnesses on the part of the Coast and Geodetic Survey. The harmonious co-operation of the three branches! What a picture of brotherly love in this modern Utopia! Here we see the different elements of soldierly pride and dignity, naval dash and pertinacity, combined and controlled, harmonized and united, under the beneficent guidance of civil attainments and tact. So much perfection must needs seek to change the aspect of Nature so as to make it conform to its own condition. Hence, we find our old notions of geography entirely out of date. Rude violence is done to our imperfect conception of the seashore, and, under the new nomenclature introduced by the Coast and Geodetic Survey, the seaman has the advantage—does he fully appreciate it?—of knowing that the Atlantic coast is not alone

> "The gutter'd rocks, the congregated sands,
> Traitors ensteep'd to clog the guiltless keel,"

but that it extends far out into the Western prairies, and is only limited by the claim of the topographers of the Pacific slope that their coast shall have a similar extension to the eastward. The Rocky Mountains have become significant features of the seashore landscape, and the grand old Father of Waters, no longer entitled to the proud distinction of being an interior and mighty river, is reduced to the category of seaside runs. Regard for an instant this naïve definition of the coast by Superintendent Hilgard (p. *30): "In fact, the terms of Section 4681 (Revised Statutes, law of 1807, already quoted) require no straining to be applied to the ascertainment of the distance and direction between Cape Cod and Cape Mendocino or between Sandy Hook and the Golden Gate."

An inspection of the charts of the Coast Survey will show, further, how much weight to place on this claim of co-ordination. The triangulation appears to have been done at one time, the topography at another, and the hydrography at still another; and finally, the assertion that "no scientific department of the Government has worked more successfully," etc., can be dismissed as idle, in view of the fact that the coast is not charted yet, although money enough has been spent to do it several times over. If this is a measure of the success of our scientific departments, we certainly overrate their importance.

The first witness before the Commission on the subject of most interest to us was Superintendent Hilgard. He defends the transcontinental triangulation on the ground that it will "bring into harmony the measurements along the Atlantic and the Pacific coasts" (p. 51).

I have thought of this sentence a great deal in the endeavor to bring it "into harmony" with common sense, but am unable to see anything more in it than a wretched play upon words which, surely, cannot be attributed to the author of such a serious assertion.

He then enunciates certain "scientific results" and "practical advantages" which relate to land surveys and have no reference to the survey proper of the coast. On p. 149 Mr. Hilgard offers the following summary in opposition to the proposed transfer:

1st. The present system, perfected nearly forty years ago, has proved thoroughly efficient, economical, and satisfactory to the country. It is wise to hold fast to that which has been proved to be good.

2d. It affords the Navy all the advantages that can be legitimately claimed. It employs as many of the officers in service afloat as can be advantageously used in hydrography. The employment of a large number, in the event of a transfer, would result in training naval officers to be geodesists, topographers, chiefs of technical bureaus, and in withdrawing their interests and habits from the naval service proper.

3d. The efficiency of the service would suffer by the loss of ambition and emulation, which exist at present in a high degree, but which find no stimulus in a service where no positions of responsibility and direction are open to civil experts, however great their attainments and devotion to the public service.

Look at the lamentable condition of this organization to-day: a prey to informers, subjected to investigations which have thrown no credit on it, in charge of a department clerk without any special knowledge of its technical necessities, and its operations condemned by eminent men both in and out of the Navy.

This is what the President thinks of it (see Annual Message, December, 1885):

This service has never been regulated by anything but the most indefinite legal enactments and the most unsatisfactory rules. It was many years ago sanctioned, apparently for a purpose regarded as temporary, and related to a survey of our coast. Having gained a place in the appropriations made by Congress, it has gradually taken to itself powers and objects not contemplated in its creation, and extended its operations until it sadly needs legislative attention.

So far as a further survey of our coast is concerned, there seems to be a

propriety in transferring that work to the Navy Department. The other duties now in charge of this establishment, if they cannot be profitably attached to some existing department or other bureau, should be prosecuted under a law exactly defining their scope and purpose, and with a careful discrimination between the scientific inquiries which may properly be assumed by the Government and those which should be undertaken by State authority or by individual enterprise.

It is hoped that the report of the Congressional Committee heretofore appointed to investigate this and other like matters will aid in the accomplishment of proper legislation on this subject.

How does this state of affairs agree with the assertion that "the present system has proved thoroughly efficient, economical and satisfactory to the country"? It may be said that this was not the result of the system, but of the inefficiency of the men who controlled it. I contend it was the natural result of a system which provided for a *necessary* work by placing it in the hands of men who speedily made it *entirely* subordinate to other work, of doubtful necessity, in which they, as landsmen, naturally took more interest. Being a technical work, it has had no supervision by the Treasury Department, as it would have had under the Navy Department, where most of the Secretary's staff is composed of men who, from experience, have a keen appreciation of the value of a chart, and comprehend the necessity of having the coast surveyed.

Let us examine still further this claim to efficiency. In the first place, it is necessary to revert to the fact already stated, and which is admitted by all the witnesses for the Coast Survey, that the *coast is not yet surveyed*, although it was commenced nearly 80 years ago, and there has been spent for this purpose the sum of $24,593,143 (see Report of Captain G. M. Wheeler, U. S. Engineers, upon the Third International Geographical Congress and Exhibition at Venice, Italy, 1881, p. 532).

A fair conclusion can be reached, also, by regarding the character of its publications with a view to the purposes for which they are intended. Director Powell, of the Geological Survey (p. 166), states:

The Coast Survey has made charts of the coast. These charts are maps of a peculiar character. The water areas are hydrographic maps, necessary for mariners, but, in order to subserve this purpose properly, certain land areas of the coast are included. On these land areas it is necessary that the salient landmarks should be plotted, as guides to mariners, and so far the work is a proper chart for mariners. But much additional material is placed on these charts. To a large extent the charts are cadastral maps on which are plotted

estates. On some of the maps relief topography also is introduced to a greater or less extent, but usually this is lacking, and when introduced it is subordinate to the cadastral purposes of the chart. . . . The Coast Survey has not made a cadastral survey by surveying properties and establishing marks on the ground, but it has made cadastral maps.

Again (p. 168):

The Coast Survey has constructed charts of the coast. These maps are very elaborate, and represent a vast system of cultural or artificial details; they are, therefore, very expensive; *they are also difficult to understand.*

Again (pp. 184–185):

They [the Coast and Geodetic Survey] have not made a cadastral map by looking up titles and plotting the boundaries of properties described in titles; but they have marked out the essential features of the estates, such as the houses, the fields, the private roads, and various matters of that nature which belong to what I have defined as a cadastral map. But where a chart is constructed in such a manner as to a large extent to neglect the natural characteristics by placing upon the chart the boundaries and improvements of estates, I have called that a cadastral map, even when it is not based upon a cadastral survey—that is, a survey intended to mark the boundary-lines of estates upon the ground.

Again (pp. 197–198):

The Coast and Geodetic Survey constructs maps, or, more properly speaking, charts of the coast. These charts represent in part water areas and in part land areas. On the water areas are represented the soundings and important features of the sea and river bottoms. Other things also are represented, such as buoys, lights, etc. The land areas represented are in part islands and in part mainland. On these land areas are represented the landmarks which are used by mariners in the navigation of the waters. So far, they are strictly coast charts, useful in navigation. In surveying the land areas, the Coast Survey does something more, by extending the map-work back a short distance into the country, varying from half a mile to five miles. This additional work is of a peculiar character. All streams, large and small, that run in or through this margin of land are plotted upon maps; all coast marshes are plotted; all rocky ledges and points are indicated, and, to some extent, hills are represented. In addition to this, many artificial features are plotted, such as city, town and village plats, country roads, farms, fields, houses, and many other artificial or cultural details. The surveys made for these cultural details do not include complete cadastral surveys, but only sufficient cadastral surveying to make it possible to correctly plot such items upon the maps.

I am unable to state any useful purpose which this cadastral or artificial element in the coast charts subserves; first, because it is not executed so as to form a complete cadastral map; second, *because these artificial topographic features are ephemeral; that is, this culture changes from year to year in such*

a manner that the charts speedily become misleading. In illustration of this fact I may state that one of the Commissioners of the Massachusetts Survey informs me that he has lately examined certain charts made in Massachusetts on this plan, and he discovers that in the areas coming under his eye, fifty per cent. of the houses placed upon the chart twenty years ago have disappeared, or been removed to new sites; that, in addition to this, a large number of new houses have been erected which do not appear on the old charts, and that the confusion arising from these two causes renders the charts almost unintelligible. He also informs me that the same confusion arises from the delineation of fences, but to a greater extent, and that a similar confusion arises through the delineation of minor public or private roads, but not to so great an extent.

Again (p. 204):

The Coast Survey endeavors to give its topographic determinations with a degree of refinement commensurate with its geodetic work, and to this end employs refined methods of instrumentation and calculation, and uses direct measurements and computations in nearly all stages of its work, to the minutest details—proceeding as if upon the theory that a cadastral survey would result therefrom, and that the boundaries of estates would ultimately be established thereby; for these more exact measurements cannot be represented upon the map.

Again (p. 206):

There is no substantial difference in the accuracy of the charts of the Coast Survey and the topographic maps of the Geological Survey *as maps.* As distances are computed in the office, the more refined methods of the Coast Survey show greater accuracy in the computations of the topographers; but this greater accuracy has no effect whatever upon the maps themselves. *If we measure a distance of* 40 *miles by a method the probable error of which is* 10 *feet, and by another method the probable error of which is* 10 *inches, the computations in the office will exhibit that difference; but that difference cannot be shown in the construction of the map itself,* and, in fact, a much greater error than that would be inappreciable upon the map.

Again (pp. 383–384):

The first question of importance in a plan for a topographic survey relates to the facts which should be represented upon the map. For all purposes for which a topographic map is made, except the functions of a military map, the natural features of the country are of prime importance. The natural features, therefore, should be represented. Of the artificial features there are two classes: Those which may be included under the term public culture, relating to the sites of towns and cities, and of highways of all classes—canals, railroads and wagon-roads; all of these should be put upon the map. There is another class of artificial features, which relate to private properties. *These are houses, fields, orchards, etc., and, as they relate to private property or estates, they may*

be called cadastral features. These should not be placed upon general topographic maps for the following reasons: First, they are so minute that they cannot be properly represented without enormously increasing the scales. Second, their delineation upon the map obscures the conventional characters used to represent natural and public topography, and, to the extent that they are introduced, the more important features are obscured: the map becomes more complex and less easily interpreted. There is yet another potent reason for their exclusion. When a map has been constructed, it must be maintained, to be of permanent value. The natural features remain, the cultural features are changeable, and those cultural features which have been denominated "cadastral" are the most changeable. If they are represented upon the topographic map, constant revision becomes necessary, and this can be accomplished only at great cost. For all these reasons it is manifest that cadastral topography should not be placed upon a general topographic map.

Again (p. 638):

I think I have clearly shown that the topographic system adopted, because of the amount of cultural features presented thereon, would speedily become obsolete, so that every few years a resurvey would become necessary; and the maintenance of such a map (of the whole U. S.) would cost many millions of dollars annually.

Commander Bartlett (p. 81) says:

I am having constant complaints from merchants and coasters with regard to the inaccuracy of coast charts.

And again (p. 892):

Errors in the charts reported by letter formed but a small portion of the whole number. Scarcely a day passed that errors or omissions were not reported unofficially by means of the telephone, and on one occasion I took with me to the Coast Survey Office more than 100 charts of different localities every one of which contained errors. These charts had been supplied to the Hydrographic Office as correct and ready for issue to our ships of war.

Again (p. 893):

In order to secure proper charts for the use of ships of war, the Hydrographer is held responsible for their accuracy. My experience with the Coast Survey charts has been such that I do not *dare* to issue them to our ships until they have been carefully examined. In case of disaster no responsibility could attach to the Coast Survey under the Treasury Department. It is therefore a necessity to keep corrected files.

Again (p. 895) Commander Bartlett says:

To prove still further that the real purpose of this organization has been either ignored or misunderstood by its directors, the charts that have been published have not satisfied the maritime community. Had this been the case, how could

it have been possible for a private individual like Eldridge to adapt these charts to the needs of seamen, and sell the reproductions at much higher prices than the Coast Survey demands for the originals? All foreign nations of importance reproduce Coast Survey charts, leaving off much of the topography and changing the skeleton or projection from the polyconic to that of Mercator.

There are many projections, but Mercator's is the only one familiar to all seamen, and upon which, with the exception of the Coast Survey, the nautical charts of all seafaring nations are based. Its advantages over the polyconic for general purposes are undeniable, and the efforts of the Coast Survey to educate seamen to accept a projection, simply because it shows topographical features with less distortion than that usually recognized as best for a sea-chart, have resulted in failure. The reasons for and against these two projections can be readily presented, and the unpopularity of the polyconic projection cannot be assigned to prejudice.

Naval officers almost universally dislike these charts on account of the polyconic projection and the use of both feet and fathoms to indicate depths of water in close proximity. One uniform system of showing depths is less confusing, and is universally in use elsewhere.

Again, the preparation of the Coast Pilot has been unnecessarily delayed, and only recently has it been finished as far as Cape Hatteras. The Navy Department has been obliged to buy Eldridge's Coast Pilot for issue to the ships of war. This is a publication, by a private individual, which covers the whole Atlantic and Gulf coasts. The Coast Survey publication, as far as it goes, is open to the same criticism of useless and unnecessary elaboration.

The following extract from a letter from Rear Admiral C. H. Davis, dated April 15, 1864, to Professor Hilgard, will be pertinent in this place. A copy of this letter has been submitted to the Commission, and will probably appear in the volume of testimony:

You cannot be surprised that I should insist, as a practical navigator, upon the use of Mercator's projection. The Mercator projection belongs to the sea, just as the modern compass does, and I may say that it finds its proper and peculiar value only on the ocean; so, also, the compass and Mercator's projection belong to each other, and neither of them is, as an instrument of navigation, complete without the other. Thus, it is only on the sea that people direct their way by the compass, both for the moment and in prospect; it is only on the sea that they have occasion to project a compass course as a guide, and it is only on Mercator's chart that such a course or rhumb-line can be projected and inspected without calculation. All this is familiar to you, as it is to me, in principle; but it is not so in practice; and it is precisely this difference in practice which prompts me to speak so freely. I think I do not go too far in saying that your not using the Mercator projection will exclude your charts from use in the merchant service, if it does not in the men-of-war of the country. If you retain the conical projection, you will be the only office in the world in which such a principle of stereography is employed for nautical charts. In truth, the

principle is defective, as applied in this case, and the Coast Survey has never hitherto admitted anything defective in principle, however insignificant in value.

The following extract from a letter from Lieutenant H. H. Barroll, on duty at the Branch Hydrographic Office, Philadelphia, is deserving of great weight in the consideration of this matter. This letter has also been submitted to the Commission, and will probably be printed with the testimony:

In this connection I would state that, having had occasion to consult with hundreds of captains of vessels, it is almost invariably their opinion that the topography of Coast Survey charts—extending for miles inland and delineating stables, barns and roads, never visible from even the mastheads of vessels—has gone as far inland as the needs of charts for maritime purposes demand.

The only practical importance of such extended topography upon marine maps would be probably to assist hostile littoral expeditions. I can readily see that such charts of foreign countries would be of great advantage to our Navy; but a chart's practical utility to merchant vessels ceases at the point at which also ceases the possible view from the vessel's deck. Large mountains, or prominent objects suitable for ranges, can be topographed upon the chart, and their heights given in figures, as in the present hydrographic system, or in those charts published by all other hydrographic offices. The general opinion of seafaring men is that there is absolutely no need on marine charts of the extensive and expensive topography of cultural peculiarities of a country, which peculiarities never meet their eyes.

Disregarding the careful work with which these outside objects have been depicted by both topographer and engraver, they generally regard the chart in the light of a chart with chromo attached. With the merchant mariner, assuredly, that chart is best which embodies in a given space the most peculiarities of the land and water-surface with which he has to deal, *and the least of that portion with which he has nothing to do.*

Coast Survey Chart No. 124 contains the entire topography of that portion of the Cape May peninsula within the limits of the chart. There is a mass of minutely executed topography, extending across the entire peninsula, wherein even out-houses are represented, although so completely surrounded by pine woods as to utterly preclude the possibility of any seaman viewing the said out-houses, except by making an especial journey by land for that purpose. At the same time, the shoals off the point of Cape May (same chart) have changed so much since surveyed that there is no dependence to be put upon Coast Survey Chart No. 124, so far as these shoals are concerned. Of what avail is the topographed position of each farmhouse to the mariner who cannot dare to trust the hydrography in order to get near enough to see the farm house?

Speaking of this chart, one of the captains in our merchant marine remarked to me three days ago: "I see there is four feet of water here" (indicating on the

north shoal off Cape May). "*I found that nearer five feet out of water, at dead low water.*" This difference of nine feet in soundings is of more importance to the merchant skipper than the topography of the whole line of Coast Survey work from Pittsburgh to Atlanta. The best proof of the preference of the merchant marine for Hydrographic or Coast Survey charts would be in the number of each sold to merchant captains.

Owing to the Hydrographic Office being restricted to foreign countries, the only charts published by both offices covering comparatively the same ground are Coast Survey Chart A, and Hydrographic Office Chart No. 942, the latter being apparently a reproduction of the U. S. Coast Survey chart, with the superfluous soundings and unnecessary topography omitted.

To satisfy myself that the ground I have taken in regard to the preference of the merchant marine for less interior detail was correct, I submitted the following letter and questions to the firm of Riggs & Brother, the leading chart dealers in this city:

[Copy.]

PHILADELPHIA, *January* 28, 1886.

MR. RICHARD RIGGS.

Dear Sir:—Will you kindly answer for me the following questions in relation to the sale of your charts? . . . . . .

1. Do you find the polyconic projection of Coast Survey Chart A, satisfactory to the majority of merchant marine officers, or do they prefer the Mercator projection of Hydrographic Chart No. 942, which covers the same ground?

2. Do you think the additional topography employed by the Coast Survey upon their charts is of material assistance to the merchant captain? By this I mean such features as do not appear in views.

3. What has been the sale of charts Coast Survey A, as compared with Hydrographic Chart No. 942 (which covers the same ground), since the date of the issue of the latter chart?

4. Do you find any objections to hydrographic charts published by the U. S. Hydrographic Office from surveys by U. S. Naval officers entirely—such, for example, as Hydrographic Chart No. 189, Harbor of Hakodadi, Japan, recently issued?

Yours very truly,

[Signed] HENRY H. BARROLL,
Lieutenant U. S. Navy.

[Copy.]

PHILADELPHIA, *January* 29, 1886.

LIEUTENANT HENRY H. BARROLL, U. S. N.

Dear Sir:—In answer to your request, we are pleased to submit the following information as received from purchasers of Hydrographic and Coast Survey charts.

In answer to your 1st and 3d we find that the Mercator projection of Chart No. 942, Hydrographic Office, is preferred nine times out of ten to that of the polyconic projection of Coast Survey Chart A.

Question 2. The additional topography upon the Coast Survey charts is not particularly desired by merchant captains, as all they desire is what appears in view, or adjacent to the coast.

Question 4. Chart No. 189, published by the Hydrographic Office, is desirable, and special charts of that character are what are generally desired by purchasers.

We are respecfully yours,

[Signed] RIGGS & BROTHER.

It would then appear that from the most severe test—from the number of persons stating preference by purchasing the chart itself—that in the *single* case where the superfluous topography can be left upon the maker's hands, the merchant marine prefer in the proportion of 9 to 1 to leave this topography and, for its price, to purchase another chart of some other quarter of the globe. . . . Coast Survey charts are acknowledged by all who understand them to be accurately constructed, and are well engraved and printed, but they *do* contain a large percentage of matter entirely useless to a person purchasing a marine map.

It is rather calculated to excite remark among sailors that summer resorts in the North, and winter resorts in the South—such places as the upper Penobscot and Mount Desert in Maine, and St. John and Indian River, Florida—have been topographed with painful exactness as to detail, while a portion of *our outer* Florida coast is untouched, and there is no proper scale Coast Survey chart of Cape Hatteras Shoals, the most dangerous point to sailors on the American continent.

Will a close examination of a Coast and Geodetic Survey chart sustain the claim that "there are no better in the world" (p. 886)? It has been considered somewhat in the light of an act of disloyalty to attempt to throw any discredit on the operations of the Survey. The mere sight of the Coast and Geodetic Survey seal is usually a sufficient argument to silence any caviler who ventures to express his opinion that a sailor needs a chart for navigation, and not a land map. As I have looked into the matter very carefully, and have had my opinion sustained by many naval officers of experience, as well as by many officers of the merchant marine, I may be excused, perhaps, for having the temerity to assert that the Coast Survey charts are *not* the best in the world. The consideration of the capabilities of the officers of the merchant marine should enter largely into the determination of what charts should represent; and I think no one will deny that a chart should have depicted on it only such matter as is of use to a sailor in navigating his ship, and that this matter should be correctly, clearly, and simply delineated.

Take, for example, Coast Survey Chart D, one of the latest issued. The polyconic projection renders it impossible to use parallel rulers, and the course cannot be projected as on Mercator's projection. Compare this with Chart No. 944, recently issued by the Hydrographic Office. Another good example is Coast Survey Chart No. 369—New York Harbor. This shows soundings so numerous as to bewilder the eye, and the topography is so elaborate, and depicts objects of such a minute character, as to confuse and obscure the delineation of those objects which might be of use as landmarks.

The chart loses much of its value, as a chart, above the entrance to the Narrows on account of the scale, but makes it up, perhaps, as a suburban guide. How much more useful to have put into a larger-scale chart of the East River some of the money spent in the topography of truck-gardens on Staten and Long Islands!

Secretary Chandler says (p. 63):

> The chart of New York Harbor, for example, contains a minute topographical map of the whole interior of Staten Island, showing roads, farms, fences and inclosures. This work, of an exceedingly expensive character, goes to swell the cost of the sailing chart without being of the slightest value to the mariner; indeed, it is a question whether such a chart would be of value to anybody, except, perhaps, to an invading army.

Where is the navigator who, going into New York Harbor after a night of anxious watching outside, will not condemn such an elaborate picture and wish for a simpler delineation which will give him the depth of water and a few conspicuous landmarks for the verification of his position? An unfortunate thumb-mark might cause a serious doubt to arise as to whether certain figures meant feet or fathoms, and I can well conceive that the perplexities of the chart might almost destroy its usefulness. There is no doubt about the accuracy of the data; there ought not to be: it has cost enough to get them; there is no doubt about the high character of the work of the naval officers; but they have contributed their intelligence and labor to aid in the production of beautiful pictures, which are more appropriate for the library and the gallery than for practical uses on board ship. The naval officers have done the hydrography, but have had no share in the question as to how it shall be used. Is not this the reasonable and inevitable sequence of a purely scientific administration of the Coast Survey?

Now let us turn to another phase of the question. The cost of the preparation (*i. e.*, drafting and engraving) of the plate of New York Harbor (Coast Survey Chart No. 369), up to the present time, is $9909. A very careful and detailed estimate made in the Hydrographic Office shows that the drafting and engraving of the hydrography ought not to have cost more than $2000. This leaves nearly $8000 for making the picture. When we consider the cost of getting the data—that is, the expense of making the survey—the figures presented by Captain Wheeler in his report, already quoted, are suggestive enough. A careful measurement of the surveyed portions of New York Harbor, as shown on Coast Survey Chart No. 369, gives 263

square miles of topography and 299 square miles of hydrography. The topography, at $333 per square mile (Wheeler, p. 533), has cost the Government $87,579, "increased by the expense of the initial astronomic work, measured bases and preliminary work." What is to be thought of such figures, particularly in view of the fact that much of the topography is out of date and wrong to-day? A note on the chart says that most of the topography was done between 1855 and 1862. According to Superintendent Hilgard (p. 155): "The country is building up on the shores of Long Island Sound, for instance, so that you would not recognize the shore from the old maps."

If this elaborate topography is made for purposes of "defense," as provided by the plan of 1843, is it not a questionable policy to publish it to the world? Being of no value to the mariner, would it not be just as serviceable for reference stored away in the archives of some Government bureau?

Is it not time that some one who can speak with authority should let Congress and the people know how much is being paid for our charts, so that this lavish expenditure for unnecessary work shall be stopped and the money put into a practical survey of the coast? The general view of the subject here presented may cast some doubt on the assertion that "the present system . . . has proved thoroughly efficient, economical and satisfactory to the country."

In regard to the conservative conclusion of Superintendent Hilgard that "it is wise to hold fast to that which has proved to be good," after what has been already said it will be only necessary to quote Mr. Chandler (p. 68): "I am not content to stand still in government. I want to see government improve practically, and if the argument 'let well enough alone' is to prevail, we shall get no improvement."

The second proposition (p. 149)—that "it [the present system] affords to the Navy all the advantages that can be legitimately claimed"—does not seem to me, from the standpoint of a naval officer, to have any weight at all. While serving in the Coast and Geodetic Survey the *status* of a naval officer is about the same as if he were on leave. The experience gained by him would be the same, in whatever department a Coast Survey might be placed, as it will always be a valuable nursery for the officers and men; but as far as the *standing* of an officer goes, he might just as well spend his time doing nothing. He goes into the Coast Survey and is forgotten until the detail clerk at the department indicates that his time has expired. His experience

is most valuable; his work, mitigated by breaks due to the large assignments of appropriations to shore work, is laborious; but where is his record? The Hydrographic Inspector can have some influence, perhaps, in determining his assignment to duty, but that is the end of it. As far as the Navy Department is concerned, he is just where he was when he left it to make his visit to another department of the Government. So much for the individual. How about the Navy in general? Very few officers realize what confusion exists in the minds generally of very intelligent people in regard to the relations of the Navy and the Coast and Geodetic Survey. I have had good opportunities of observing this, and my experience leads me to the conclusion that the general sentiment is that the Navy has nothing to do with the Coast and Geodetic Survey. At all events, this body is pre-eminent, and the Navy is relegated to such a subordinate part in its operations that it is never heard of. When we consider that the survey of the coast is probably the most important public work this Government has ever undertaken, and that the Navy has contributed by far the most important part of it, it seems almost incomprehensible to me that the Navy has not demanded its share of the public credit, and insisted upon it so unanimously and so forcibly that its proper influence in this heterogeneous partnership should appear to all men.

In the testimony of Assistant Boutelle in answer to "What has the Coast and Geodetic Survey done for science?" (p. 870), the omnivorous character of this organization is well exemplified. Although he mentions individuals by name and does not stint his commendation of their work, the effect of the whole paper is to absorb the efforts of all contributing agencies, and we unconsciously yield to the influence of this draught of self-adulation and are no longer shocked that so small a body should swallow the earth, as it practically claims to have done (see Assistant Baker's testimony, before quoted).

This all-pervading and overwhelming influence of the civil staff of the Coast and Geodetic Survey is boldly enunciated in Superintendent Hilgard's third and last proposition (p. 149): "The efficiency of the *service* would suffer by the loss of ambition and emulation .... which find no stimulus in a service where no positions of responsibility and direction are open to civil experts." This, being freely rendered, means that the "service" depends entirely on the civil assistants, who will not work unless they continue just as they are, and, therefore, we cannot expect any more good charts.

The second part of Superintendent Hilgard's statement—that "a transfer would result in training naval officers to be geodesists, topographers," etc.—is sufficiently answered by Commander Bartlett (p. 894):

The primary survey of the Atlantic and Gulf coasts should have been finished years ago.

A survey for the purpose of commerce and navigation should be accurate—that is, such a degree of accuracy, and no greater, should be obtained as can be represented on the charts. The hydrography should be based on a triangulation including measured bases, and the topography should embrace such natural and artificial objects as will serve as aids to navigation. In general, astronomic observations for latitude, longitude, the variation of the compass, and tidal observations, complete the list of operations necessary to secure the data for a nautical chart.

The triangulation should not be of geodetic refinement, as that necessitates great expense without securing adequate results. It is not desirable to determine the position of a point within a fraction of an inch when a dot on a chart of the largest scale covers more than one hundred inches. A small error may be magnified when carried through a long distance, but this cannot develop if the triangulation is properly checked.

The topography inside of the shore-line should embrace only a few prominent objects. In these days, when artificial aids to navigation, such as buoys and beacons, are so numerous, very little topography is necessary for the seaman's use. The fact that elaborate detail of topography is unnecessary will be fully understood when it is considered that vessels go into our harbors about as freely at night as during the day. In view of this fact, also, it will be seen that the expenditure of much time and money in getting the exact outline of the shore within limits which cannot be shown on a sheet of paper, is hardly defensible when such outlay could have been employed to obtain soundings of dangerous parts of the coast yet uncharted.

Director Powell also says (p. 168):

In complex scientific mensuration the several kinds of measurement used in the several parts of a great work should be correlated with each other; one part should not be more refined than another, and none of the parts should be more refined than is necessary for the purpose to be subserved. The reason for this is very simple. Every additional degree of refinement in measurements is attained only by additional expense of time and costly apparatus, and in general the expense increases at a ratio higher than the refinement. The principle which I have thus enunciated is the great economic law of scientific research.

The work of the naval officers attached to the Ranger, the Pinta, and the Coast Survey vessels working in Alaska, is perfectly satisfactory, although they are *not* geodesists or topographers by profession.

The following testimony in regard to the competency of naval officers will be edifying to those who have had experience in surveying. Referring to the interior geodetic work, Superintendent Hilgard says: "We take some competent gentleman of the locality, such as a college professor approved by the Governor" (p. 55). This gives us an insight of the methods by which the Coast Survey has gained so many respectable backers, and also contrasts remarkably with statements on p. 151:

Q. Am I right in understanding you to say that bright young men recently graduated at the Naval Academy would be able to learn in one season how to do geodetic work?

A. No, sir, not the geodetic work.

Q. Explain why they would not be able to do the geodetic work.

A. They have to learn it. They could in one season familiarize themselves in observing, when working alongside of an experienced chief. They could make a selection of signals, and they could aid him in observing; but experience requires a long time, say five years.

There is more interesting testimony on the point that a college professor can leave his class-room and, without experience, suddenly develop into an observer of sufficient merit to have his work accepted and made part of the refined geodetic survey, while a naval officer cannot learn to do the work in less than five years.

Assistant Mitchell (p. 545) says:

Q. Suppose the entire work of the Survey were to be transferred to the Navy Department . . . . would the men who are now engaged in the work be still required?

A. They would be absolutely required, unless an interval of several years is to be given to teaching the naval officers the land work.

Q. Will not the naval officer easily learn to execute the hydrography and topography together? Or what is the impediment in the way of a naval officer's making both those surveys? They seem to be closely and intimately connected.

A. They are closely and intimately connected, but they use entirely different instruments. The plane table is the instrument used by the operator on shore, and he requires a training of four or five years. It is apparently a simple instrument, but it requires great skill in the operator, and our best topographers have had twenty years' experience. The naval officers can learn it just as any other young men can, but they cannot do the work without a long training.

Assistant Colonna (p. 770) states in regard to this matter:

Q. These professors who are employed as acting assistants have—some of them—never had any training in making observations in the field before their employment, have they?

A. It is very true that they never have had.

Q. Is their work generally accepted or rejected by the Coast Survey?

A. I have never known it to be rejected.

Q. Are the young men educated in the Naval Academy sufficiently educated to enable them to make good assistants in the Coast Survey?

A. It takes a training of five or six years before I consider a man proficient, and he needs then to pursue the calling with singleness of purpose, devoting his whole time and energy to it.

Again (p. 772):

Q. I desire to get a little clearer idea as to the extent to which the work of these professors, when they act as assistants, is accepted.

A. The whole of it is accepted for what it is worth. I do not know of any of it having been rejected.

Q. Do you mean to say that other assistants of the Coast Survey go to work and change the points that they (the professors) have located in the field?

A. No, sir; . . . . but they do not send their records into the office in good shape. A man will make a certain record and give no explanation of it, and we have to write to find out what it means; but when we get an explanation, it is perfectly plain, generally.

Q. But is theirs (the work of the professors) accepted and taken as part of the work?

A. Yes, sir.

Q. And not done over again?

A. No, sir.

There is more of the same sort of contradictory nonsense in regard to this subject. As a matter of fact, the Coast and Geodetic Survey has been glad to obtain the services and accept the work of any gentleman whose influence might be of value in any emergency. It would be quite unnecessary to consume time and space in explaining to naval officers, and particularly to those who have been engaged in surveying, the absurd nature of this pretension that it would require five years for a naval officer to learn to do the shore work necessary for a nautical survey; for this is what lies at the bottom of these assertions, that the transfer should not be made because naval officers cannot learn to do a necessary part of the work in the time usually allotted to them for this service. It must be very evident, even to those unacquainted with the details of surveying, that this position is untenable, in view of the fact that college professors can do the work sufficiently well without previous experience.

What special quality is this, beyond the reach of other men, which lies within the faculties of the assistants of the Coast and Geodetic Survey and their occasional companions, the college professors?

What a monstrous claim to excellence which insists that the sole power of manipulating surveying instruments rests with one class of men to the exclusion of all others! Even the work of the topographers of the Geological Survey (p. 620), and that of the engineers of the Army (p. 630), is sneered at, and the attempt is made to force the conclusion that the survey of the coast must remain in the hands of this superior set of mortals, that a large force of naval officers and men and more than $250,000 of the naval appropriation must continue to be farmed out annually to the Coast and Geodetic Survey, because, forsooth! a naval officer can never learn to handle those magical instruments of precision, the theodolite and plane table.

The remainder of the testimony of Supt. Hilgard relates to the undertaking of the Coast Survey to make a general trigonometric survey of the whole country and its collateral operations, the compilation of a general map of the United States, the error in distances due to the deflection of the plumb-line, the relations of the Coast and Geodetic Survey with the Geological Survey, which is also carrying on a topographical survey of the United States, and various details of coast work which are not strictly pertinent to the object of this paper.

There has been no denial on the part of the witnesses of the Coast and Geodetic Survey that the naval officers do all the hydrographic work. That they do it is affirmed, however, and it is generally admitted that they should continue to do it, although under greater restrictions than heretofore. Assistant Colonna, who must be considered as the mouthpiece of the Survey, being its executive officer and official representative before the Commission, makes certain statements which will give the officers of the Navy an idea of how their services are regarded (p. 550):

> I think you gentlemen [the Commission] must be quite surfeited in considering our relation with the Navy and hydrographic work, etc. I have noticed several times in the newspapers, of late, statements that the Coast Survey costs the Navy two hundred and odd thousand dollars a year for soundings, which is very true; and, moreover, it takes one-third of our appropriation for purposes of Coast Survey field work, which makes altogether about $337,900 for the fiscal year 1885 that has been spent simply for hydrography. That expenditure, for results obtained, is outrageous. Yet it has been used as an argument to show that the hydrographic work of the Coast Survey should be transferred entirely to the Navy Department, because they say the Navy pays for nearly all this work. I do not wish to be understood as arguing that the hydrographic work should be taken away from Navy officers working in the Coast Survey. There are reasons why the Navy should naturally do that work, but under proper

restrictions, and just where they are now doing it—that is, in the Coast and Geodetic Survey.

Again (p. 553):

I just simply rebel at the idea, when I consider the work accomplished and its cost by the civil force, and compare it with the work done and cost of it by the Navy, of saying that it is a matter of economy to have this work done by the Navy. Put it in the hands of the Navy, in its entirety or in part, and they will bring up a similar set of civilians to that we have now. The only thing gained will be that the experienced surveyor and the blue-jacket will have arrived at the same level, to be commanded by an ensign instead of the men who have experience in this business that civil officers of the Coast Survey have.

Again (p. 554):

We have to equip and man these vessels and get them to sea, which is all right; but when they come in, say for all winter, they should be put in charge of shipkeeper, laid up, as it is called, which costs about $50 per month. Such is always done with vessels commanded by a civilian. If, however, it is a naval officer who commands, she is laid up as a boarding-house, with cooks, stewards and servants, and even very nearly a full complement, all told, on board, and she is kept in full commission until she is needed to go out again. I will cite you the steamer Patterson, built for Alaska work. That vessel came into the harbor of San Francisco on October 5, and she lies there now with a full crew aboard, numbering thirty-nine persons, at an expense of over $1588 per month, with not a single thing for these people to do in prospect for six months to come. It is true it comes out of the Navy appropriation, but it comes out of the Treasury, after all, and it is charged against the Coast Survey by naval officers desirous of a change, as a valid reason why such change should be made. No such expenses of laying up as those of the Patterson, Hassler, and other vessels, would ever be permitted a civil party, and it is unjust to charge such expenditures, made in accordance with naval customs and regulations, to a civil bureau where they are tolerated, but not approved.

Again (p. 555):

The men commanding these vessels are educated for and worthy to defend their country's honor on the high seas; but when they come to us they are not surveyors, and they leave about the time they become proficient. The post-graduate course we give them is a valuable one, but it ought not to cost so much.

The opinion of so competent an authority as Superintendent Thorn must not be omitted (p. 613): "Expensive work in hydrography is the price of the proper tuition of a small annual detachment of young naval officers in local geography."

Mr. Colonna says (p. 556):

Q. If I understand you, then, Mr. Colonna, you would have in the naval appropriation bill the appropriation for seamen, and so on, in the Coast Survey a separate item?

A. I would have that a separate item and attached to the appropriation bill for the Coast Survey, and make the Superintendent of the Coast Survey responsible for its expenditure, so that when officers were detailed from the Navy and went into the Coast Survey they would only receive what they are absolutely furnished by the Coast Survey, and on a civil basis. I would absolutely put the thing on a civil basis if I wanted to get the work performed at the most reasonable price and in the most excellent manner.

Q. In other words, instead of enlisting sailors you would hire men?

A. I would hire sailors just as they are hired in the merchant marine. The best sailors we have are in the merchant marine. You can rarely get a really number one sailor to go aboard of a man-of-war, because of the discipline there; because he sees positively no chance on earth for advancement; his way is blocked; he can possibly get to be a petty officer, but cannot get any further. An American does not like that plan. And you will rarely find a first-class New England sailor on a man-of-war.

Q. How much of a saving can be made by adopting your plan?

A. I think that $100,000 would be saved to the Government annually if, instead of allowing $256,000 to be spent from the naval appropriation annually, the Coast Survey appropriation were increased $156,000, and the whole appropriation be put in manageable shape under the hand of a strong Superintendent. It would not admit of any scientific humbuggery, but lots of good, honest, hard work could be done, and results adequate to the expenditure be obtained. The Coast and Geodetic Survey could be well managed with a gross appropriation of $725,000, which is the estimate of this year, plus $156,000 for hydrography.

On page 594 Assistant Colonna gives a comparison between the "cost of the Coast and Geodetic Survey schooner Earnest, commanded by a Lieutenant in the Navy, doing hydrographic work on Hood's Canal and vicinity, southwest of Admiralty Inlet, in Washington Territory, and that of the Yukon, commanded by civil assistants of the Coast Survey, working in similar smooth waters to the Earnest" (see pp. 593–595):

For the naval-officered Coast Survey vessel for fifteen months.....	$8,889 44
And for the civil-officered Coast Survey vessel for fifteen months....	4,525 97
A difference of.....	$4,363 47
Now, counting all salaries and expenses, we have:	
For the naval-officered vessel, fifteen months' expenses.....	$13,173 25
For the civil-officered vessel, fifteen months' expenses.....	9,668 00
Naval in excess of civil, for fifteen months.....	$3,505 25
Deduct this amount from salary and allowance for civil officers for fifteen months.....	5,142 85
And we find that it only lacks, in order to leave the naval officer at home on full pay and allowance, an additional saving in this case of	$1,637 60

And if you disregard the fact of the charge of the salary of one assistant in the Yukon party, which was accidental only, and arose from the fact that he had sustained injuries in the prosecution of his duty which prevented him from performing the active field work himself, it will be found that it would have been cheaper to have left the naval officer on shore with full pay and turned the work of the Earnest over to a civilian by about $108, and this, too, carrying the naval officers at full pay. If he had been left at home on waiting orders, there would have been a saving to the Treasury of $1017, they being carried at minimum.

An examination of these tables from another point of view shows the following:

The only expenses under control of chiefs of party are

	Navy.	C. Survey.		
Current expenses	$643 72	$1063 19		
Repairs of vessel	235 16	387 58		
Shipkeeping	.....	392 00		
	$878 88	$1842 77		
		878 88		
Balance in favor of navy	.....	.....	$963 89	

Expenses under control of Superintendent of Coast Survey and Hydrographic Inspector:

	Navy saves.	C. S. loses.		
By detaching officer when laid up, leaving him for other duty	$679 00			
More officers when laid up than when at work	.....	$833 00		
		679 00		
Balance in favor of navy	.....	.....	$1512 00	
	Navy saves.	C. S. saves.		
Discharging men when laid up	$2390 76	$3888 99		
		2390 76		
Balance in favor of C. S.	.....	.....	$1498 23	
Balance for navy	.....	.....	.....	$ 13 77
Add balance (table preceding)	.....	.....	.....	963 89
Total balance in favor of navy	.....	.....	.....	$977 66

Again (pp. 597–598) we find the following strange doctrine with regard to the authority of the Superintendent of the Coast Survey:

Q. Let me finish my question. We will start again. This abuse that you have spoken of, arising from the fact that the naval officers in each of these Coast Survey vessels keep under pay, when the vessels are laid up during the winter, a larger number of employés than there is any necessity for, has been going on all the time. You mean to say that this is just a fair sample of what has been done for years under the Coast Survey, do you not?

A. That is not something for which the naval officers or the Superintendent of the Coast Survey are responsible.

Q. But, I ask, is it not a fair example of what has been done?

A. It has been going on for years and years, and is a part of the naval system which naval officers brought to the Survey with them and have kept up.

Q. That naval system has been under the control of the Superintendent of the Coast Survey, has it not?

A. No, sir.

Q. Has not the Superintendent of the Coast Survey had the right all the time to order and control the vessels of the Coast Survey, and to say how many employés there should be?

A. No, sir; he has not had that right in fact.

Q. Has he had it in law, according to the law and regulations?

A. No, sir. Custom is our only law and regulation that I know of on this point, and this is a naval custom. The Navy brought it to us and have kept it with us through their own officers. This is a fault of the naval system, to which it is proposed to transfer work and not war. The naval man-of-war goes under commission, and she stays under commission until put out of commission. The naval officer comes to the Coast Survey, and has from the time of its first organization; but they have brought the naval system into the Coast Survey with them. It is that system that keeps the vessel in commission, and it is that system—good for war vessels, bad for working vessels—that I would advise to be broken under the present organization, rather than have it perpetuated by transferring the hydrography to the Navy Department. It is not the naval officer who is to blame who is on duty in the Coast Survey, nor is it the Superintendent of the Coast Survey. It is the system that he brings from his man-of-war and applies to a working vessel that is at fault. That same officer would work in the same way if you transferred the Coast Survey to the Naval Department. If it goes there, you will never see that this fault exists. The Navy will never see it. It will be swallowed up in their general system. This is absolutely the last view that you can have of naval methods of work, if the transfer is made. You will never know what the work does cost, and it will continue to be run just exactly in the way I have described, for no one will have any interest in breaking it up. There will be a thousand and one excuses and ways of explaining the expenses. I am well aware that I am encountering an enemy to our time-honored institution who is on the alert, well intrenched, and with an almost impenetrable picket line, along which a tremendous social and political influence keeps an untiring watch.

To show the consistency of this witness, see p. 605: "The Superintendent of the Coast Survey has it in his power, whenever he chooses to exercise that authority, to call the Inspector to account about any matter."

Again (pp. 614, 615, 616):

Q. You have stated that, in your judgment, the hydrographic work under the present system is performed with reasonable satisfaction?

A. Yes, sir.

Q. But you assume that there is an undue expenditure of $100,000?

A. Yes, sir.

Q. You have also stated your opinion to be that in case of the transfer to the Navy Department the expense would not be diminished?

A. I think in that event it would increase.

Q. In what way, in your judgment, can that evil be remedied?

A. By keeping it right in the Coast Survey—with the organization just as it is; by putting a strong man as Superintendent of the Coast Survey, who will say, when work is completed for the season, "Lay up your vessel and dispense with your crews"; and let him have the authorities back him up in what he directs.

Q. That, in your judgment, can be readily effected without any change in the law?

A. Without any change in law at all.

Q. Simply by properly administering the law?

A. That is all it needs; no changes needed at all in law.

Q. Should there be no change in reference to the detail of naval officers, and putting them under the charge of the Coast Survey for the performance of this work?

A. I see no necessity for further law to aid in details. The detail could be made just as exact as it is now.

Q. How do you propose to correct this undue expenditure of money in vessels under the charge of naval officers?

A. Just when the time comes to lay the vessel up, the Superintendent should say, "Put one man on board of her, or two men if necessary," instead of allowing an Inspector to say it; and he should see that it was done, allowing the naval officers to go home or elsewhere and wait until the vessel was ready to go to work, and then put them on board again.

Q. You do not mean to say that the Superintendent has not a sufficient authority, if he sees fit to exercise it?

A. He has sufficient power to do it, if he sees fit to exercise that power, I think; but custom has made an unwritten law for us.

Q. But I understand that the naval officers in charge of those vessels in commission, as in the Navy, were not subject to the Superintendent of the Coast Survey?

A. They are subject to the Superintendent, but in the matter of not laying up vessels when unemployed is a naval custom that has been brought into the Sur-

vey which I think would not be allowed, custom or no custom, to the extent it is, if the Superintendent of the Coast Survey felt that he was strong enough, and exercised his authority as he should.

Q. It is a question of administration, then?

A. It is a question of administration.

Q. The system of employing naval officers to co-operate with civilians, as they do now in the Coast Survey, has been in vogue all the way from 1843 down to the present time, has it not, with the exception of the period of the war and a short time afterwards?

A. Yes, sir; I think it is a very good arrangement, too.

Q. If the law is administered as now proposed under present, temporary organization, and so continued in the permanent organization of the Coast Survey that may be effected, will this saving of $100,000 result?

A. Yes, sir, I think so; if a strong man is put at the head of affairs in the Coast Survey, it certainly will;—a man who does his duty, and does it right; strongly supported by the authorities.

Q. The trouble, then, in reference to undue expense has arisen from the inefficient administration?

A. Yes, sir; in my opinion, it has.

Q. When did that inefficient administration begin?

A. In a greater or less degree it has been running in the Coast Survey ever since I knew anything about it, but it has reached its maximum in the last three years.

Q. How long have you been in the Coast Survey?

A. Fifteen years.

Q. Is this custom of which you speak—of keeping those vessels in commission all the year round—a new custom?

A. As old as the system itself, I think.

Q. That is, dating back as far as 1843?

A. To the best of my knowledge and belief.

Q. So this inefficient administration is not a new thing?

A. No, sir; not a new thing.

. . . . . .

Q. . . . . I propound a question as to whether this expense resulted on account of inefficiency on the part of the Superintendent of the Coast Survey. Does or does not that inefficiency by which the excees of $100,000 is expended relate to his omission to enforce his authority in regard to the expenditures made on vessels in commission under the Navy Department?

A. That is just exactly what it relates to.

I have called attention to these disconnected statements of Assistant Colonna in order to show to the officers of the Navy just how much credit they are getting for their work from the Coast and Geodetic Survey officials. As a matter of fact, the officers have always been a necessary evil, for a geodetic survey would never have stood on its own merits before. It is possible that the people may not be ready

yet to indulge in such a luxury. The various statements made by Assistant Colonna were so completely refuted by Lieutenant-Commander Brownson, the present Hydrographic Inspector, that I have transcribed his exceedingly interesting testimony almost entirely (pp. 879-887):

The total appropriation for the Coast Survey for the year ending June, 1885 was $518,000. Now, of this amount there was appropriated for all field work—geodesy, furnishing points for State surveys, topography, hydrography, etc., and everything of that kind—$154,000. Of this amount there was expended by naval parties for hydrography, $37,387—for outfit, coal, etc. I think that was the question you were trying to get at a few moments ago, and I call your attention to the small amount of it expended for hydrography for the fiscal year ending June 30, 1885.

Q. That did not include the pay of the Navy officers?

A. No, sir. The field work, or work of all parties engaged in collecting data away from the office for the purposes of the Coast Survey, cost $154,000, but only $37,387 of it was expended under the Navy.

Q. Does that include also the fitting out of the Coast Survey vessels?

A. That includes everything except the repairs of the vessel. I am referring now only to the appropriation of the $154,000. . . . There was an additional appropriation for repairs of vessels, including new boilers for the Hassler (and I would also add that the Bache received new boilers out of this appropriation), of $42,000. The whole amount of pay and rations, officers and men, serving on the Navy vessels employed in the Survey was $239,033.34.

Q. That is for naval officers?

A. For pay and rations of all naval officers and all enlisted men serving on the Coast Survey.

Q. Does that include what is known as extra allowance? There are, we are told, certain extra allowances made to officers on the Coast Survey.

A. There was during one year an allowance varying from $15 to $30 per month for subsistence. That ran through a period of a little less than one year.

Q. That was not in 1885?

A. Yes, it ran into 1885; but it was stopped by Mr. Thorn, so that practically that allowance had only been paid for one year since 1860. The law always admitted of it, but it never was paid, except as stated.

Q. Except in 1885?

A. Except in 1885, up to the time the payment was stopped.

Q. In your statement of the $37,387 for hydrography did you also include that additional expenditure?

A. Yes, sir, I did.

Q. Then that additional expenditure is probably not included in Mr. Colonna's statement of $256,000. I wanted to see whether or not that difference was not accounted for in the shape of extra allowances.

A. He refers to the pay and rations of the Navy. This makes the total cost of hydrography, including pay and rations to officers, $318,420.34, making

the total cost of the Coast Survey for that year $836,420.34. Mr. Colonna claims that this $239,033.34 is very much in excess of what it should be. In other words, he claims that the administration of the Navy in the Survey is bad as regards the handling of crews and the laying up of vessels, and cites, among other cases, the case of the Patterson, a vessel which was constructed entirely for work in Alaska. This vessel works where she is cut off from all machine-shops, and all places from which she could recruit her crew. It is a matter of prime necessity that she should have an intelligent and experienced set of men. If a man turns out bad or unsuitable in any way, they cannot get rid of him up there. They cannot replace him, because there is no one up there to enlist.

It is not thought expedient, in these exceptional parties on the Pacific coast, to discharge men while waiting for work in the spring which will begin probably about the 20th of March, or between that and the 1st of April. It is as difficult to replace our boat-steerers and leadsmen in the hydrographic parties as the observers. At times it is more difficult, and in running a range in a strong tide-way it is necessary to have experienced men.

There is another point, too, about the discharge of these men, and that is that the service of many of them is practically continuous. I have known men in the Survey who have been there twelve years. Those men, of course, know everything about the work. They have become themselves almost hydrographers by means of their long acquaintance with the work, and to discharge them would certainly be very unjust. If this is "Navy methods," then we pursue it, notwithstanding the slur that has been cast at it by Mr. Colonna.

Mr. Colonna submitted to you also a table, in which he showed the vessels at present at work in the Survey, and the number of officers and men that there were aboard of them. This table is made out, it is supposed, for November 30, and this date is one between the working seasons. He gives not only the officers, but also the men. Where he obtained the data for this table I cannot tell. For that date I do not have it myself. The quarterly returns are the only ones that will show it, and the last one was on the first of October. The table is very misleading as regards the number of officers and men. The Eagre, the Drift, the Palinurus, the Ready, and the Daisy, five vessels used by naval parties during the summer, had 67 men on board when at work. In accordance with instructions which had been issued, that force was reduced when they were laid up to 27 men, which they have now. The chiefs of parties were ordered to select such men as were of the most use to the Survey, including in each case carpenters and machinists. The officer in charge of these vessels is supposed during the winter to keep them in proper condition, and the service of these men will enable him to have the vessels ready for work next April without submitting an estimate for repairs. In other words, these men are, by their work on the vessels, not only saving money to the Government in this way, but they are a nucleus of experienced men which, with the addition of the working complement of seamen in the spring, will form a good hydrographic party.

As an instance of the work done by these men, the commanding officer of

the Bache submitted, a short time ago, an estimate for $650 for new decks for that vessel. That was, however, more money than we could spare for that purpose. I sent him directions to take these five carpenters in addition to his own, buy the material, and lay the decks. The cost of that deck was $171.34 as against $650, which was the bid of a reliable shipbuilding firm. Their men would have been paid $2.50 to $3 a day, while we had the work done by our own men.

Q. On the regular pay-roll as seamen?

A. Yes. It was a great saving in that way.

The table also shows, I notice, that Mr. Colonna has put down certain vessels which had been used by civil parties as "laid up all right," while the Arago appears as last used by a naval party, and "laid up over a year," the natural inference being that there was something wrong in the case of the latter vessel. As a matter of fact, she has been laid up just as the others have been, with one or two men on board. The table is misleading, as already shown, by the statement that we had 67 men on certain vessels, when in reality there were only 27.

Then, again, just as soon as the civil parties get through with their vessels, the care of them is immediately turned over to the Navy, and we have to stand the expense of looking out for those vessels during the winter. When a topographical party wants the vessel, the man aboard is discharged from the Navy rolls and taken up on the civil force.

Also, Mr. Colonna does not bring to your attention the fact that these men whom we keep aboard the vessels in New York—to which he seems to object—are not only repairing the ships that are going to be used for the hydrographic work, but are also putting in order those that will be used by the civil parties.

Q. For what?

A. For topography and current work; and all that goes against the Navy pay—$239,000.

Q. You regard these expenditures made for hydrography during the fiscal year 1885 as made with reasonable economy and prudence under the charge of naval officers?

A. Undoubtedly. They could resort to a cheese-paring process of economy that would cut it down. I do not mean to say that it could not be reduced, but I say the reduction would be small, and there would be corresponding loss of work.

Q. And reduction at the expense of efficiency?

A. Yes.

Then Mr. Colonna comes down to the number of vessels in the Survey, and he says there are twenty-five; and he wants to sell some of them. We have twenty-five vessels in the Coast Survey, of which number ten are steamers. There are three schooners unfit for use, and I shall recommend that they be sold at the first opportunity. Another, the Daisy, is a tender to a vessel; still, she is included in this list of steamers. The number of vessels, when thus reduced, will not be greater than will be required for the hydrographic parties and civil

parties together. *Mr. Colonna wants to retain those for the civil parties, but he does not say much about retaining those which are engaged in the hydrography, which, as I understand it, has been the mainstay of the service since it was organized. Or, in other words, it furnishes the information which is of the most importance to the navigator.*

Q. The original object of the Coast Survey organization was to survey the coast?

A. That was the original object.

Here is another answer of Mr. Colonna [referring to page 557 of the testimony], which hardly seems to merit a reply, where he refers to the Navy:

To the number of men that may be employed on Coast Survey work there is, you will observe, no stated limit. They get as many vessels as they can, and put as many officers and men on them as they can, and make it as easy for themselves as they can; that is not work, nor is it business; but it is what you may expect and what will go on without check if this is handed over to the Navy. The Navy is as fine a set of fighters as the sun ever shone on, but they are not surveyors, as a rule, in a practical sense.

It is a well-known fact among the officers of the Navy, and the civil assistants also, with the exception of Mr. Colonna, that the Navy officers in the Coast Survey are a very hard-working set of men. I have undertaken to get some facts, and have written to the chiefs of parties during the past summer to give me their standing orders regarding hours of work. I find that the boats left the ships at from 7 to 7.30 A. M., returning at from 5 to 6 P. M.

I say that practically the amount of work done by hydrographic parties is limited only by daylight and the endurance of the men.

Officers accept this duty for two reasons. Those who lead parties accept it because they get command of a ship. The ensigns and junior officers accept the duty because they have more responsibility thrown on their shoulders, get better quarters, and are more independent. The training that officers get on the Coast Survey is the very best that we have—not alone as hydrographers, but as naval officers, as increasing their efficiency as sea officers.

Q. As a rule they are not averse to this work?

A. No, sir. We have little difficulty in getting all the officers that we want. Many are very glad to get on that work instead of serving on ships of war; but they do more work in the Coast Survey than they do on board a man-of-war. They do this simply because they get the increased responsibility and better quarters.

In a previous statement Mr. Colonna says they are not surveyors, and something also about it taking three years to become a hydrographer. The naval officers come into the Coast Survey very well equipped for the work. They have an extended knowledge of the use of instruments, of the handling of boats, and, what is about as important, experience in the handling of men. Any officer of two or three years' experience after leaving the naval school will make a good hydrographer at the end of a month or six weeks. He will get the aid of all the little tricks that have been learned as the result of experience from the other people on board of the surveying vessel. It would hardly do to fit out a hydrographic party with all new men, because their records would not be

so complete or systematic. And then, again, they would have no one to impart to them the many technical wrinkles which come as the result of years of experience. They are very quickly acquired, however, these little arts to which I refer, that tend to systematize and shorten the work.

Q. How about topography on shore? What is your experience or observation in that respect?

A. I think there is no doubt that they can do it. As regards the topography, I think they would not resort to the same degree of refinement that the assistants reach after their use of the plane table for years. But they can do all the topography that is necessary for a chart.

Q. How about the triangulation on shore?

A. They can do all that is necessary; the points are already furnished us.

Q. But as to those points where the work is not already complete?

A. They can carry it on. Lieutenant Clover, in command of the Patterson, has been doing this work in Alaska—triangulation, topography and hydrography—with a naval party. There was one civil assistant sent by the Superintendent to do the astronomical work, but the party was complete without him, and the commanding officer did not want him.

Q. Do you think you could organize out of the hydrographic service a party that could complete the shore work as far as it is left incomplete by the Coast Survey?

A. Without any doubt, sir.

Q. And do it as well as they have done their work?

A. Yes, as regards chart work. I do not say they would get the same refinement in topography that these gentlemen do, but I say as regards the shore line and all topographical features necessary to a navigator they can do it.

Q. Do you think they could do the triangulation without any difficulty?

A. All that is left to be done.

Q. That is, they could fill out the Coast Survey work?

A. Yes.

Q. You think they could take up the work right where it is?

A. Yes; they are doing that work in Alaska now.

Q. You think this could be done entirely by the hydrographic parties of the Navy Department without reference to the Coast Survey?

A. I do. From Mr. Colonna's strictures regarding naval officers as hydrographers, one would suppose that he had had a very extended experience in this branch of surveying, but the records of the office show that his experience is very limited. I think he has done less hydrographic work than a young naval officer would do in two months on the Survey. I speak of this because he has not had the experience—according to his own testimony, where he said that the study of three years was necessary to make a hydrographer—to entitle his opinion to any value.

Q. You say you are responsible for and in control of all the hydrography that is being done by the Coast Survey Bureau?

A. No, sir; if I conveyed that idea, I certainly did not mean to. I intended

to say that I was responsible for the naval administration in the Survey as regards the crews, laying up of vessels, etc.

Q. Do you control the hydrography proper now?

A. Under the direction of the Superintendent, I do. As he is new to the office, it is controlled by the advice of the Hydrographic Inspector.

Q. While Mr. Hilgard was there, and before Mr. Thorn came in, to what extent did Superintendent Hilgard direct and control you? Did he adopt, generally, your suggestions, and were you practically in control?

A. I did not serve under him. I did not relieve Commander Chester until after he was deposed. But the usual method of procedure was for the Hydrographic Inspector to submit a scheme of the work he considered advisable, which the Superintendent either approved, modified, or rejected, as the case might be.

Q. You do not know, then, except from hearsay?

A. I can simply say that it was usual for him to adopt the most of the Inspector's suggestions. *It depended on the appropriations, and in the main they were so divided that the civil parties got what they wanted and the remainder went to the naval parties.* The work of the naval parties depended on how much they received.

The following extract from a letter of Lieut.-Com. Brownson is a part of the record:

Those portions of this testimony wherein reference is made to the Navy and to naval methods consist in great part of assertions which betray ignorance or show lack of full comprehension of the subject. Some of these assertions cannot be allowed to pass unchallenged; but the impression they have produced is probably not as great as to make necessary a lengthy and wearisome exhibit in order to show their fallacy.

The burden of certain parts of this testimony which call for brief notice is to the effect that wasteful methods are practised in carrying on the hydrographic work of the Coast Survey under Navy officers, in consequence of which this work costs annually $100,000 more than it should. This sum would appear to have been named at random; but, once stated, it is repeated as if it had been determined by some logical examination of the question. According to brief explanatory remarks occurring several times, but always in the most general terms, this saving is to be effected by the discharge of crews when vessels are unemployed.

This proposition shows lack of careful consideration, as may be readily shown by quoting a few figures from Mr. Colonna's testimony and from the papers submitted by him. A statement incorporated in his testimony gives the average annual cost of the hydrographic work of the Coast Survey done by naval parties during a period of ten years as follows:

Pay and rations, naval force, from Navy appropriation	$242,000
Party expenses, naval force, from Coast and Geodetic Survey appropriation	55,000
Repairs, etc., from Coast and Geodetic Survey appropriation	33,000
Total	$330,000

Thus the average annual cost of this hydrographic work is stated to be $330,000, of which it is asserted that $100,000 might be saved.

The last two items of the statement are actual working expenses, covering repairs, outfit, and supplies of material used in carrying on the work. *When parties are laid up, it is generally because of the small amount apportioned from the Coast and Geodetic Survey appropriation for these expenses.* True economy would demand a larger amount, that, possessing the plant already, the work might go on continuously. No criticism appears to be made of present expenditures under these items; certainly none could be justly made.

The saving is to be effected, then, in the item of $242,000 for pay and rations of officers and men. But the pay and rations of officers must be excepted, for this witness says:

"It is a question of the saving of about $100,000. You can keep it [the hydrographic work] where it is, put all the money intended for hydrographic use, *except the salaries of officers and their rations*, in the Coast Survey appropriation, to be spent under the Superintendent of the Coast Survey, and save $100,000."

The italics are mine. Following Mr. Colonna in this, and deducting the amounts for pay and rations of officers, which he states elsewhere to be $106,000, there remains a sum of $136,000, of which $100,000 is to be saved.

Deducting the $100,000 to be saved, we have left $36,000 with which to pay and feed during one year the crews of all the Coast Survey vessels engaged in hydrographic work, as well as all shipkeepers; the absurdity of which is evident.

In my own testimony before the Commission I have referred to this question of discharging crews in all cases as soon as work stops, and I shall not do so here further than to remark that the matter is a minor one of administration, requiring knowledge of the special circumstances in each case, and coming directly within the scope of the duties of the Hydrographic Inspector. If Mr. Colonna's crude suggestion were followed in all cases, the result would probably appear to show a saving on the face of the accounts. The result of a careful computation, which covers a year during which circumstances cause the showing against the present system to be peculiarly unfavorable, and in which all doubtful elements are so entered as to make the result still more unfavorable, shows that the saving to be effected amounts to less than $23,000, and this at the expense of efficiency.

Mr. Colonna submits a comparative statement of the expenses of the schooner Yukon in the hands of a civil party, and those of the schooner Earnest in the hands of a naval party, and the showing, as he puts it, is unfavorable for the latter. As it is my purpose to be brief, I shall not go into an analysis of the statement, further than to say that instead of being a fair comparison and example it is really most unfair, and the case an exceptional one. The two parties were equipped for totally different kinds of work. One was to do topography, the vessel serving simply as headquarters for the small force needed. The other was to do hydrography, using steam launch and pulling boats, and required a large force. *After equipping at considerable expense,*

the party on board the Earnest was ordered, by direction of the Superintendent of the Coast Survey, to cease operations, although a slight additional allowance of money would have enabled work to be carried on with gratifying results. The crew was reduced; all were not discharged. I have already considered the question of discharging crews on the Pacific coast, when I had the honor to appear before the Commission.

The consideration of the expense of this work will be of interest. Director Powell testifies (p. 638) that the cost of the topography executed by the Coast Survey has been $100 per square mile, and that the map they propose to make will consist of 400,000 sheets, to cost $350,000,000. This cost of $100 per square mile is admitted by the witnesses, and it is not denied that it costs more.

The most conclusive *résumé* of this question, which is based on information received directly from the Coast Survey Office, is found on pp. 532–533 of the exhaustive, comprehensive and exceedingly interesting report of Captain G. M. Wheeler, U. S. Engineers, already referred to.

"The amounts appropriated for this work from 1806 to June 30, 1886, aggregate $20,072,136.56. The current annual appropriation is $523,398.82, with $100,000 for purchase of vessels."

"There has been directly expended by the Coast Survey from its own appropriations to June 30, 1884, the sum of $19,349,112.03 (see Sen. Ex. Doc. No. 35, 31st Cong., 2d Sess., and testimony before Joint Congressional Commission, p. 61). The above is independent of the expense borne by Army and Navy appropriations. The former ceased during the War of the Rebellion."

"The Secretary of the Navy, in his annual report for 1882, gives the following as actual expenditures from Navy appropriations for the Coast Survey: 1879, $260,870.63; 1880, $229,969.32; 1881, $220,931.64. The expense borne by the War Department is not known."

"Commander Sigsbee, U. S. Navy, estimates (see p. 252 Annual Report of Secretary of the Navy, 1882) $4,000,000 as the lowest total estimated amount of expenditure for all years (presumably to June 30, 1882), thus aggregating an expenditure (actual and estimated) to June 30, 1884, of $23,349,122.03, with the cost to the Navy of two additional years. Every expense for the fiscal year ending June 30, 1885, is given (see p. 553 of testimony) at $449,324. This swells the actual direct expenditure to June 30, 1885, to the sum of $19,798,436.03. Add $201,563.07 (an amount presumably underestimated), an assumed expenditure for the half year ending January 1, 1886

(making round numbers), and there results the sum of $20,000,000. To the $4,000,000 (estimated cost to Navy to June 30, 1882) the sum of $593,143, being for 2½ years to January 1, 1886, at an average of $237,257.20 (see. Annual Report of Secretary of the Navy, p. 252), and there results as a total direct Navy expenditure (estimated) $4,592,143. The aggregate of expenditure to January 1, 1886, thus reaches the figure of $24,593,143. The relative percentage of hydrographic to trigonometric work is estimated as $\frac{3}{10}$ and $\frac{2}{10}$ of the whole, and that for topography at $\frac{4}{10}$, with the balance, or $\frac{1}{10}$, for work of a general character. (See p. 148 of testimony before Joint Congressional Commission.) Grouping the official data, all from the office of the Coast Survey, there results the following table:

Class of work.	Area in sq. miles.	Total estimated cost of same.	Cost per sq. mile.	Remarks.
Triangulation.....	199,864	$4,918,628 60	$ 25 80	Both coastwise and interior.
Topography.....	31,919	9,837,257 20	308 00	Add cost of triangulation, base and astronomic work for cost of 1 sq. mile, topography mapped.
Hydrography (inshore).	26,093	7,377,943 90	93 00	Add cost of triangulation, base and astronomic work for cost of 1 sq. mile, hydrography mapped.
Hydrography (offshore)	53,030			

"The cost to the United States, as above shown, for one square mile of topography on the resultant map would be $333, increased by the expense of the initial astronomic work, measured bases, and preliminary work, which are presumably a part of the one-tenth for general work. The cost of the inshore hydrography (being more detailed) is probably at least three times as much as that of the offshore; hence, the sum of $93 per square mile represents only a part of the true cost of one square mile of complete, detailed hydrography."

"The above is the most complete estimate yet made of the actual cost of finished work by this office. General Comstock made an estimate, based on Coast Survey reports from 1858 to 1872, of the average cost for 14 years as follows: "Triangulation per square mile, $120; topography per square mile, 283; hydrography per square mile, 80. (See Sen. Ex. Doc. No. 21, Part II., 45th Cong., 3d Sess., 30th January, 1879.) The amount for topography *per se* is not far

different from that obtained by measuring the final total results and taking the corresponding total cost. The item for triangulation, however, varies greatly. At that date not so large a proportionate part of offshore hydrography had been done."

One more consideration demands attention. The acquisition of modern war ships may bring in its train such changes in organization as will effect results long desired. This is the belief of some, at least, and the hope of many. It seems to me, however, a doubtful consummation, unless some imperative occasion should arise to call a widespread attention to the Navy, and give it the support of a strong and favorable public sentiment. The demand for the most efficient service would then force the organization to conform to the necessities of the situation, and complaints of defective administration would not be so frequent.

Without this special occasion we cannot count on the interest of those of our people whose homes are not within easy striking distance of the seacoast, and the most we can expect to secure is the attention and assistance of the commercial classes of the seaboard and their most worthy associates, the mercantile marine. No effort should be spared to bring the Navy into favorable relations with these classes, and its services, freely offered and wisely distributed, will react in the strongest measures of public sympathy and support. This has been fully exemplified by the successful career of the Hydrographic Office during the last two years and a half. Excluded from the direction of the special service which would bring it into the closest relations with the individuals of the maritime community, it has yet found much to do for their benefit and instruction, and stands as high to-day in the popular regard as any bureau of the Government.

That service, however, which the Navy performs most acceptably, and which, under proper management, would bring the largest measure of credit to the Navy Department, is swallowed up in the assets of the Treasury, and the identity of the body which surveys the coast is lost in the operations of the Coast and Geodetic Survey. The influence which naturally accrues to the direction of this great and valuable work is lost to the department which furnishes the workmen and a large share of the money for its prosecution. Can the Navy afford to bear this loss any longer?

U. S. HYDROGRAPHIC OFFICE,
April, 1886.

PROFESSIONAL NOTES.

A STRANGE FAILURE OF STEEL BOILERS.

[From the London *Engineer*.]

The peculiarity of the boilers under consideration consisted in the fact that (1) the material used passed all the tests required by the Board of Trade and Lloyd's; (2) the material stood without the slightest defect the ordinary work of the boiler shop, including welding, etc.; (3) each set of boilers worked most satisfactorily at sea for a period of two and a half years, after which they then exhibited signs that a complete change had taken place in the steel.

The design of the boilers was such as to give no reasons whatever for the strange behavior of the material, being the ordinary double-ended, cylindrical type with three plain, welded furnaces opening into a separate chamber for the set of three at each end, and having on top of each boiler an ordinary cylindrical drum.

From the commencement of the working of these boilers the usual treatment was adopted, zinc being used in blocks of the Admiralty pattern, and special attention was giving to careful scaling. The first signs of a change commenced with an extensive crack in one of the combustion chamber plates on steamer No. 1. This crack, 2 ft. 6 in. long and opening from $\frac{1}{8}$ to $\frac{1}{16}$ in., occurred spontaneously in the month of August, three weeks after the boilers had been blown down, and at the time no work was being done except the usual scaling.

The next occurrence was of a similar nature, but happened to steamer No. 2, when the boilers had reached the same period of working as those on steamer No. 1. This extensive crack occurred in a corresponding plate in the same combustion chamber to the first one, thirteen days after steam had been let down. The report was so loud as to almost deafen a boilermaker at work about the bridges. Owing to this crack being similar to the first one, it was decided to test the other plates of the chamber by hammer blows, with the result that three of the other similar plates were cracked, either vertically or horizontally. Some of the cracks commenced at first by showing a peculiar black shade, about $\frac{1}{2}$ in. broad, in the direction the crack was likely to occur, and after another blow a faint score, like a hair, became visible, which could be seen gradually opening and extending; others cracked simultaneously with the blow, but none with the loud report of the originals. About this time, also, small cracks were found between rivet holes in the furnace fronts and backs, saddle plates, etc.; so that it was evident something unusual was taking place, as previous to this no sign of brittleness had ever been found.

The next crack occurred a few months after on steamer No. 2, when under steam on a long passage home. It was first noticed at sea by the water flowing from the ash-pit, and as no sudden leak took place, it was surmised that the crack opened gradually and salted up as it extended.

At about this time the most serious defect occurred in steamer No. 1, when lying in a colonial port, a few days after steam had been let off. An extensive circumferential crack occurred in one of the wing furnaces. This crack took place with a loud report, commenced about 4 inches under grate bars, and extended upward about 22 inches.

Previous to the receipt of this news, a series of extensive tests had been made in the presence of a Board of Trade official on strips taken from the

cracked plates cut out of both vessels. From these, and also from the chemical tests, no definite signs of an entire change in the material were discovered which would account for the cracks or justify the costly step of removing the boilers, although brittle portions had been found here and there. The analyst's report of the steel was "that, chemically speaking, it is not at all objectionable, being a material of good average quality."

Another instance of the peculiar nature of the steel was found on the last voyage made with the boilers, and consisted of two bulges on the furnace crown close to the back end; the plates in the neighborhood of these bulges showed no signs of brittleness even when put back, whereas numerous cracks were found between the rivet holes at each end, both prior to and after the putting back.

Owing to these occurrences it was decided to have new steel boilers, and when the work of breaking up the old boilers commenced, the results were startling, and of such interest as to bear an extended description. The first start was made by knocking off the rivet heads on the connecting pipes between boilers and drums; but after a few blows it was discovered that the pipes were cracking in all directions, and to such an extent, eventually, that not one of the nine connecting pipes came off whole; then, after the drum had been removed from one boiler, a portion of one of the pipe flanges was being wedged from the boiler, when the shell plate suddenly cracked for about ten inches. When the furnaces and front plates were started upon, a general smash was experienced, the front plates cracking and starring and the flanges breaking off, the furnaces at the same time acting in the same manner, cracking through the rivet holes to such an extent as to allow the ends to come off whole in hoops.

During the construction of the boiler no special means were adopted. The steel, which was made by the Bessemer process, at the works of a prominent steel company, worked in a most satisfactory way, welding and flanging without the least trouble; the holes in shell and other circular portions were drilled; the furnaces, after being welded, were carefully annealed to the special instructions of the Board of Trade, the work throughout being regularly inspected by their surveyors and those of Lloyd's Registry, the material having also been periodically tested at the manufacturers' by both these boards.

It will now be interesting to endeavor to obtain, if possible, some satisfactory reasons for the failure of these boilers; otherwise, the unpleasant fact must be acknowledged that it is yet possible for material to be put into boilers which after a time will become treacherous, notwithstanding the extensive tests and rigid inspections now made.

J. K. B.

NOTES ON LIQUID FUEL.

[From the London *Times*.]

The expenditure of ingenuity, time and money which has been going steadily on for many years past in the endeavor to utilize hydrocarbons as fuel under boilers for raising steam, testifies to the importance of the subject, while the persistency with which it continues to be pursued bears witness to its fascination, and to the valuable character of the results which are expected to follow practical success. That success would mean an enormous saving in our solid-fuel coal, while our steamships would be relieved of some 50 per cent. of their fuel weight, which could be either assigned to cargo, or, on long voyages, a double supply of liquid fuel could be carried. So long ago as 1830 Mr. H. Pinkus claimed to have used hydrocarbons in conjunction with streams of vapor for steam-raising purposes, and from that time down to the present, engineers and inventors have not, for any length of time, ceased to labor in the same direction. Richardson's petroleum furnace, as well as that of Bridges

Adams, was for many years under the notice of the officials in Woolwich Dockyards, and in 1868 the Government permitted Wise, Field, and Aydon's systems of using petroleum by the aid of an induced current to be applied to a marine boiler on board a steam yacht. The same system had also been previously applied to a Cornish boiler at some large works in London. The Admiralty also tried at Sheerness a somewhat similar plan, invented by Mr. S. E. Crow, but, as in the Woolwich trials, without any practical result. In the same year, which appears to have been marked by a sudden outbreak of inventive activity in connection with the subject of liquid fuel, Dorsett's petroleum furnace was fitted under the boilers of the steamship Retriever, of 90-horse power and 500 tons burden, and some very successful runs were made with her. But, as far as the use of the system in England went, nothing further appears to have resulted, the reason being, we believe, that directly a demand was created for the class of liquid fuel used, and which at that time was a drug on the market, the prices went up to a prohibitive extent.

In France corresponding attention was paid to the same subject and in the same year, one system tried there being that of M. Verstraët, a chemist. It was applied to a locomotive on the Eastern of France Railway, and upon the occasion of the Emperor visiting the camp at Châlons the train was drawn by the engine thus fitted. His Majesty rode on the foot-plate of the engine, in company with MM. Sauvage, Dieudonné, and Sainte-Claire-Deville. In the same year, His Majesty also made a run in the Puebla, a steamer in which mineral oil was employed to raise the steam for the engines. In America, liquid fuel has been used both on locomotives and in steamers, and at one time, we believe, to a considerable extent, but, notwithstanding the advantages offered in the way of cheap and plenteous liquid fuel, it would seem to have had but a very limited application in practice for steam-raising purposes. In Russia a very different condition of matters exists, inasmuch as for some years past petroleum refuse has been used for fuel in the locomotives of the Grazi Tsaritsin Railway, in the southeast of Russia, the first trials on that line having been made in 1874. Besides this, numbers of steamers are now running on the Caspian Sea which are using liquid fuel. Moreover, in consequence of the comparative scarcity and dearness of petroleum in this country, a fleet of large tank-steamers is being built by the Russian Black Sea Navigation Company to bring the Russian oil to Europe in bulk.

In view of the undoubted importance of the liquid-fuel question, it will be interesting now to notice its latest phase, as brought under our notice on Wednesday in the steamship Himalaya. This is a trading vessel of 100-horse power, nominal, and 800 tons burden. She is 210 feet long, and 28 feet beam, and is fitted with compound engines, driving a screw propeller. The boilers have three furnaces, each of which has a fire-brick lining with apertures on the principle of the Siemens regenerative system. At the end of each furnace is a fire-brick baffle having an opening through which the heat passes to the tubes from the furnace, or, as it may be more correctly called, the combustion chamber. In this chamber is a coil of iron pipes, one end of which is connected with the steam space of the boiler and the other opens at the door of the chamber. This coil is for the purpose of superheating steam taken from the boiler, and by which an induced current is set up which carries the petroleum forward into the combustion chamber. In order to enable it to do this, the petroleum nozzle is placed within the steam pipe at the opening where it delivers its jet, so that an annular space is formed, through which the steam rushes, and, combining with the small but regular flow of oil, produces a large body of flame within the chamber. The oil is stored in tanks on the main deck, whence it flows by gravity to the delivery nozzles at the furnaces. The whole apparatus is very simple and very easily adjustable; one important feature is that in the event of the oil not being obtainable at any port where fuel is required it can be removed, and the fire bars for burning coal replaced in a very short time. Another important feature of the system which we should mention (the invention of Mr. Percy F. Tarbutt) is the method of

starting the furnace, which is effected by a very simple arrangement, whereby sufficient steam is quickly raised to start and maintain combustion until the steam pressure in the boilers is sufficient for that purpose.

The Himalaya was purchased by the Marahû Petroleum and Oil Produce Company, of Suffolk House, Cannon street, London, and by them has been fitted with the apparatus we have described, in order to practically and commercially test the system. She will, however, be renamed the Marahû, after her owners, the Marahû Company. The coal-carrying capacity of this vessel is said to be 240 tons, and her consumption of that fuel is put at nine tons per day. She will now carry only 90 tons of oil, her consumption of liquid fuel being put at 3½ tons per day, thus giving, as we have already observed, a great increase of cargo capacity. A large party of engineers and other gentlemen interested in the present question visited the Himalaya on Wednesday and inspected the furnaces and oil equipment of that vessel. Although only that morning completed, the apparatus worked very well, combustion being nearly perfect, as evidenced by the very small amount of smoke that issued from her funnel. A fairly steady steam pressure of 55 pounds per square inch was maintained, the steam, of course, being blown off as made. The demonstration, in fact, was perfectly successful. The ship will start to-morrow on a trial trip to Leith and back. She will be accompanied on the trip by a Board of Trade surveyor, as well as by one of Lloyd's surveyors, both of which departments are evincing great interest in the trial. After that she will proceed to Glasgow to take in a cargo, which she will carry to Brazil. It is then intended to employ her for trading purposes along the coast of Brazil, her supply of liquid fuel being obtained there from the works of the company to whom she belongs.

Such is the latest phase of the liquid-fuel question, which appears to be nearing solution as regards steamships. It appears to be clearly demonstrated that petroleum can be used as fuel. The only disturbing element as regards commercial success here is the uncertainty and the cost of the supply. This difficulty surmounted—and it would seem that Russian enterprise is about to make an attempt to surmount it—and prejudice and conflicting interests overcome, there would appear to be a hopeful future for liquid fuel in this country. In fact, Wednesday's demonstration looks like the beginning of the end.

It is feared that the sanguine expectations expressed in the preceding article will not be realized in the near future, as the impracticability of the general use of liquid fuel by any system tested up to the present time, when considered from a commercial standpoint, is distinctly shown by the following tables, taken from a paper read before the Engineers' Club of Philadelphia, by Mr. James Beatty, Jr., member, and printed in the *American Engineer*:

"The fuels to be considered are anthracite and bituminous coals, crude petroleum, and coal, generator and water gases. The average compositions of these fuels (considering only the heating agents), as deduced from the analyses of eminent chemists, are:

	Percentage by Weight.					
	C.	H.	O.	CO.	CH_4.	C_2H_4.
Anthracite	87.7	3.3	3.2			
Bituminous	80.8	5.0	8.2			
Petroleum.....	84.8	13.1	1.5			
Coal gas.....		6.5		14.3	52.4	14.8
Generator gas.....		1.98		35.5	1.46	
Water gas.....		6.3	.6	87.8	1.2	

"We will employ the formula of Dulong,

$$h = 14{,}500\,C + 62{,}000\left(H - \frac{O}{8}\right),$$

to compute the theoretical heating powers of these fuels. In the case of methane, CH_4, the formula is not true, but the error is not great enough to seriously affect the result. This gives for the combustion of one pound of

Anthracite	14,500 Br. heat units.
Bituminous	14,200 "
Petroleum	20,300 "
Coal gas	20,200 "
Generator gas	3,100 "
Water gas	8,500 "

"Reducing the above to terms of pounds of water evaporated from 212° F., we have :

	Pounds of Water evaporated from 212° F.
Anthracite	15.023
Bituminous	14.69
Petroleum	21.00
Coal gas	20.87
Generator gas	3.21
Water gas	8.7

"The results of experiments show the efficiency of fluid-burning furnaces to be about 90 per cent., while with coal 60 per cent. may be taken as a good figure. The great difference in the efficiencies is due to the fact that fluid fuels require for combustion very little air above the theoretical quantity, while with the solid fuels fully twice the theoretical quantity must be admitted to dilute the products of combustion.

"Correcting our previous results from these efficiencies, we have :

"Pounds of water actually evaporated from 212° F. :

	Per pound of Fuel.
Anthracite	9.0
Bituminous	8.8
Petroleum	18.9
Coal gas	18.8
Generator gas	2.9
Water gas	7.8

"These figures agree closely with the results of experiments.

"We will now consider the subject of cost.

"The following cities have been selected, as manufacturing centres, termini of railroads, or fueling ports of steamers.

"In the case of petroleum, as it is rarely shipped in the crude state, an approximation is made by adding to the cost to the nearest shipping port the freight charged on refined petroleum, and ten per cent. to cover duties and other charges.

"Owing to the difficulty in obtaining prices in some of the cities, there may be some errors.

Costs, March, 1884.

	Anthracite, per ton of 2240 lbs.	Bituminous, per ton of 2240 lbs.	Coal gas, per 1000 cu. feet.	Generator gas, per 1000 cubic feet.	Crude petroleum, per bbl. of 42 gallons.	Water gas, per 1000 cubic feet.
New York	$4 00	$4 25	$1 75	$0 45	$1 80	$0 50
Chicago	5 00	3 50	1 25	0 45	2 00	0 50
New Orleans	6 00	3 50	3 00	0 45	2 50	0 50
San Francisco	12 00	7 50	3 00	0 55	2 00	0 60
London	5 00	3 00	0 75	0 43	2 70	0 45
Port Natal	12 50	11 00	...	...	4 00	...
Sydney	12 00	7 00	...	...	4 50	...
Valparaiso	11 50	7 50	...	...	3 00	...

"In calculating the following table the specific gravity of coal gas is taken at .4; generator gas at .44; water gas at .48; petroleum at .8.

Pounds of Fuel for $1. *March*, 1884.

	Anthracite.	Bituminous.	Petroleum.	Coal Gas.	Water Gas.	Generator Gas.
New York	560	527	156	18	74	76
Chicago	448	640	142	24	74	76
New Orleans	374	640	114	10	74	76
San Francisco	187	299	142	10	62	62
London	448	747	104	40	82	79
Port Natal	179	204	71	...	...	...
Sydney	187	320	63	...	...	...
Valparaiso	195	299	94	...	...	...

"These figures, multiplied by the actual evaporative powers as calculated, give:

Pounds of Water Evaporated from 212° *F. for* $1.

	Anthracite.	Bituminous.	Petroleum.	Coal Gas.	Generator Gas.	Water Gas.
New York	5040	4643	2948	338	220	577
Chicago	4032	5638	2684	451	220	577
New Orleans	3366	5638	2155	188	220	577
San Francisco	1683	2634	2684	188	179	484
London	4032	6581	1966	751	228	640
Port Natal	1611	1797	1342	...	...	...
Sydney	1683	2819	1191	...	...	...
Valparaiso	1755	2634	1776	...	...	...

Relative Costs.

New York	$1 00	$1 08	$1 71	$14 92	$22 90	$8 70
Chicago	1 00	0 71	1 50	8 72	18 30	7 00
New Orleans	1 00	0 59	1 56	17 90	15 30	5 80
San Francisco	1 00	0 64	0 63	8 75	9 40	3 50
London	1 00	0 61	2 05	7 16	17 70	6 30
Port Natal	1 00	0 90	1 21	...	...	...
Sydney	1 00	0 34	1 39	...	...	...
Valparaiso	1 00	0 44	1 03	...	...	...

In the years 1866-7 the Bureau of Steam Engineering of the Navy Department made an elaborate series of experiments to ascertain the value of crude petroleum as a fuel for generating steam in marine boilers. These trials were considered to have solved the engineering problem concerned in the use of

petroleum, as the apparatus invented by First Assistant Engineer Clark Fisher, of the United States Navy, was found to be a complete success. It was similar in principle to the apparatus described above as fitted to the Himalaya, but was more complete in having an additional annular space about the steam jet for the supply of air. Thus the steam not only atomized the petroleum, but diffused throughout it the air necessary for combustion.

Chief Engineer B. F. Isherwood, then Chief of the Bureau of Steam Engineering, discussed the results of the trials in his annual report, dated October 25, 1867, as follows:

"With Fisher's apparatus it is found that, other things equal, the heat generated by the combustion of one pound of crude petroleum vaporizes fifty-two per cent. more water than that generated by the combustion of one pound of the combustible portion of anthracite; by combustible portion is meant the part which remains after deducting the earthy matter. To cause the complete combustion of the petroleum, about one-twelfth of the steam generated by it has to be used in the furnace, leaving the effective vaporizations produced by the two fuels to compare as 1.00 for the anthracite combustible and 1.40 for the petroleum. And, as the earthy matter of good, merchantable anthracite is about one-sixth of its weight, the effective vaporization produced by equal weights of anthracite and petroleum will compare as 1.00 for the former to 1.68 for the latter. These figures are, of course, for the same weight of anthracite combustible and of petroleum consumed in the same time in the same boiler.

"The advantages of the substitution of petroleum for anthracite would then be a reduction of forty and a half per cent. of the weight of fuel now carried in the vessel; and as the cubic foot of petroleum weighs at ordinary temperatures fifty pounds, while the cubic foot of anthracite as stowed in bunkers weighs fifty-three and one-third pounds, there would be a reduction of bulk of thirty-six and a half per cent.

"As, however, the iron tanks required to hold the petroleum would weigh considerably more than the bunkers holding the anthracite, and as some space must necessarily be lost in storing them, it may be assumed that the substitution of petroleum for anthracite would reduce both the weight and space required for the latter about one-third. But if safety required the petroleum tanks to be immersed in water, as at present seems probable, then no saving of weight could be effected, but only a saving of space occupied. The weight of the boiler, including its water, and the space occupied by it and the fire-room, could be reduced twenty-eight and a half per cent. The first cost and after repairs of the boiler would also be reduced to the same extent. The number of firemen required with petroleum would not exceed one-fourth the number required with anthracite, leaving their pay and subsistence to be saved, as well as their weight and that of their effects and subsistence, and the space occupied by all three on board. The petroleum fire starts into full activity instantaneously, and is as instantaneously extinguished, while the coal fire requires about an hour to attain steady action, and as long to burn out. These are very important advantages; but against them are to be placed:

1st. The danger resulting from the very volatile gases which petroleum emits at ordinary atmospheric temperatures, and which, when mixed with air, are highly explosive. In the hold of steamers the temperature around the engine and boiler-rooms averages as high as one hundred degrees Fahrenheit, and greatly aggravates this danger. Indeed, when it is considered that a medium-sized navy steamer would have to carry about two hundred and fifty tons of petroleum, which, however well protected in tanks, is liable by a single shot to be poured in large quantities into the boiler-room, where its gases, mixed with the air and ignited by the fires of the furnaces, would explode with terrific effect, liberating other quantities and destroying almost instantaneously both vessel and crew, this objection seems so serious that the most overwhelming advantages are required to justify the risk of its use. As merchant steamers do not engage in battle, this risk would be less for them, but it would cause a high

rate of insurance and loss of passenger transportation, even if officers and crew could be found for excessive pay to brave the danger.

"2d. Owing to the rapid conversion into gases of a portion of it at ordinary atmospheric temperatures, the loss of petroleum by volatilization is very great, and this loss proportionally increases its cost, while it decreases its advantages as regards bulk, weight, and evaporative efficiency.

"3d. And, due to the same fact of its easy gasification, it fills the air with a noisome stench, which, in the confined hold and badly ventilated compartments of vessels, would be intolerable.

"4th. The price of crude petroleum is, by weight, about eight times that of coal, and a large demand would increase the disparity.

"From these considerations, it appears that the use of petroleum as a fuel for steamers is hopeless; convenience is against it, comfort is against it, health is against it, economy is against it, and safety is against it. Opposed to these, the advantages of the probably not very important reduction in bulk and weight, with their attending economies, cannot prevail."

The ratio of the effective evaporative efficiencies of anthracite and petroleum as given by Isherwood, 1 to 1.68, is undoubtedly more reliable than Mr. Beatty's estimate, 1 to 2.1, which does not give evidence of including the loss from the use of steam in burning the petroleum. Thus, if Isherwood's ratio be adopted, the relative cost of evaporating water by coal and petroleum would show an increase of twenty per cent. over the figures given by Mr. Beatty.

It will be noticed that San Francisco is the only place shown where it is more economical to use petroleum than coal, and, curiously enough, it appears to be the only place in America where it is used in a steamer. There the large ferry-boat, owned by the Central Pacific Railroad, for transporting the overland trains from Port Costa to Benicia employs petroleum furnaces. The circumstances are peculiarly favorable to economy, as the vessel remains at the dock for some time between the short runs, occupying about forty minutes. On reaching the dock the supply of fuel is stopped completely, and the heat stored in the bricks forming the furnaces is sufficient to keep up steam.

It may be argued that the matter of greater cost of petroleum does not render its use commercially impracticable, as the saving in cargo space from the reduction of bulk of the fuel and the reduction in weight and space for boilers would increase the earning capacity of a steamer to such an extent as to overcome the loss upon the fuel. In some special cases this might occur, but ordinarily there would appear to be an invariable loss, without considering the rise in the price of petroleum if generally used as steamship fuel, or the increase in rates of insurance.

For war purposes, considered apart from the question of cost, we may say that if we agree to provide for the use of petroleum when full power is required, or as emergency fuel, then the weight of boilers may be reduced by about one-third for the same space. The question is whether this gain in useful displacement can be utilized to such advantage as to counterbalance the enormous additional risks involved by the use of petroleum.

F. T. B.

REPORT BY A BOARD OF U. S. NAVAL ENGINEERS ON THE RELATIVE STEERING EFFICIENCIES OF THE RUDDER ALONE, AND THE KUNSTADTER SYSTEM OF RUDDER AND SWIVELLING SCREW.

In this report will be found the dimensions and descriptions of the hull, screw, boilers and motive engines of the vessel, and of the two systems of steering in question; a description of the manner in which the experiments

were made, and of the means by which they were made; large tables in which every experimental quantity, either of observation or calculation, will be found systematically arranged, and in connection with which are explanations of the quantities in these tables, showing how they were obtained; an investigation into the principles which govern the action of each of the two systems of steering; a statement of the general laws discovered by reason and confirmed by the experimental measures in the two cases; also, a statement of the practical results as ascertained for both systems; and, finally, a comparison of the experimental results, and of the value of the two steering systems.

The experiments were made for every five degrees of rudder angle between 10 and 45°, and made for turning the vessel first to starboard and then to port, the mean being taken as the true result, each turning being repeated from five to seven times in order to obtain an accurate mean. These trials were repeated for three rates of speed. The power exerted by the engine was correctly ascertained in each case; during the experiments, over 13,000 indicator diagrams were taken and computed.

Among many other determinations, the experiments show that the resistance of a given plane moving in water, and inclined at different angles of obliquity to the direction of its motion, experiences a resistance in the direct ratio of the sine of the angle of obliquity; that the diameters of the turning circles of a vessel at constant speed upon the circumferences of those circles, and steered by the rudder alone, are in the ratio of the product of the natural sine and cosine of the angles made by the rudder with the keel; that the diameter of the turning circle with same rudder angle is greatly influenced by the speed of the vessel on the circumference of that circle, becoming larger as the speed increases; and that the angle of greatest steering effect for the rudder alone is 45°.

For the Kunstadter system, the experiments have shown that the vessel steered by it has the diameters of its turning circles in the direct ratio of the natural cotangents of the angles made by the rudder with the keel from aft, provided the vessel has a constant speed on the circumferences of those circles; and that their diameters are affected by difference in these speeds in the same manner and to the same degree as in the case of the rudder alone, becoming larger as the speed increases.

The report also shows for the first time the causes which determine the "drift angle" or turning angle of the vessel, and the method of calculating it with exactness when the diameter of the turning circle is known. The "drift angle" is the angle made by the central longitudinal plane of the vessel with a tangent to the circumference of the turning circle, at the point where the centre of gravity of the vessel coincides with or is over that circumference. This angle is constant for the same vessel and the same diameter of turning circle during the entire time that the vessel is making a revolution around the circle. If the diameter of the circle be increased, the "drift angle" is lessened, and *vice-versa*.

The report also shows that the vessel does not pass around upon the circumference of the turning circle as though it lay fixed across that circumference at the "drift angle" and was carried around upon the circumference broadside to, as it were, by a force following the circumferential direction. The vessel follows the circumference as the resultant of two component forces acting independently of each other, so that the movement obtained from its screw is always in the direction of its central longitudinal plane, while it simultaneously undergoes a purely rotary movement on its centre of gravity from the force derived from the reaction of the water upon the rudder.

The small screw, steering screw, or Kunstadter screw, as it is severally named, is of cast iron, the blades and hub forming a single casting. The shaft of the small screw is supported in a continuous bearing extending clear across the rudder. The shaft is cased with brass, and runs on lignum-vitæ bushings in the usual manner. The thrust of the screw, in both going ahead and backing,

is taken through a brass collar and lignum-vitæ bearing by the rudder, to the pintals of which it is transferred, and by them to the rudder-post and hull. The brass collar and lignum-vitæ bearing are at each end of the rudder, those for the going-ahead thrust being at the after end. By this arrangement the small screw is supported overhung just abaft the rudder, and when the main screw and the Kunstadter screw are at right angles to the central longitudinal plane of the vessel, the axes of their shafts are in the same straight line.

The small screw makes revolution for revolution with the large one, the two being connected by a universal joint lying directly between them, and enabling the axis of the small screw to be placed, by a force acting on the rudder, at any angle less than about 55° with the axis of the large screw. The small screw thus becomes a steering screw, in addition to the rudder.

The universal joint connecting the main and small screws is of the utmost mechanical simplicity, convenience and efficiency.

The experiments made with the two systems of steering consisted—1, in ascertaining the performance of the Nina over a straight base with and without the small screw; 2, backing trials in a straight line at the maximum, with and without the small screw; and 3, turning trials.

The primary object of making the runs over the bases was to ascertain the distance in feet that the vessel passed through the water in a straight line per revolution of the speed register, an instrument that was employed for determining the lengths of the circumferences of the circles described by the centre of gravity of the vessel with different angles of helm. When the small or Kunstadter screw was not used, there were utilized in the propulsion of the vessel 75.882 per cent. of the net horse-power developed by the engine, and when the small screw was used, there were utilized in the propulsion of the vessel 74.386 per cent. of the net horse-power developed. This difference is an economical loss of about 1½ per cent. of the net power, and was accounted as being wholly due to the malproportion of the two screws used.

All attempts to steer the Nina when backing with the main screw alone proved completely abortive. The position of the rudder seemed to produce absolutely no effect, and the result was the same whether the rudder was in the line of the keel or made any angle with it up to 45°, and on either side. With the small or Kunstadter screw in use, it was possible, by careful watching and quick handling of the helm, to back the vessel in a straight line.

The object of the turning trials was competitive—to ascertain, in the two cases of steering, the diameters of the circles respectively made by the centre of gravity of the hull with the rudder and with the axis of the Kunstadter screw at the angles of 10, 15, 20, 25, 30, 35, 40 and 45°, the vessel turning both to starboard and to port at three rates of speed. It was found that the relative steering efficiencies of the two systems varied largely with different angles of the rudder. At the rudder angle of 45°, the steering efficiency of the rudder alone was nearly 66 per cent. less than that of the Kunstadter system, the diameters of the turning circles in the two cases being nearly in the rates of 166 for the rudder alone and 100 for the Kunstadter system. As the rudder angle decreases, the Kunstadter system gradually loses its superiority, until at the angle of about 25° the steering efficiencies of the two systems are about equal. Below the rudder angle of 25° the rudder alone gradually gains in superiority, until at 10° it exceeds the Kunstadter system in steering efficiency nearly 15 per cent., the diameters of the turning circles comparing as 85 for the rudder alone and 100 for the Kunstadter system.

It is stated that, had the Nina been fitted with a rudder and fixed propelling screw of the proportions to the hull found in the best engineering practice, instead of the exaggerated proportions they actually had, the superiority of the Kunstadter system at 45°, instead of being 66 per cent. greater than the rudder alone at the same angle, would have been about 100 per cent. greater, as the turning circles with that angle of rudder would have been about one-half the diameter with the Kunstadter system that it would have been with the rudder alone.

The best arrangement of the two screws, as the result of the experiments with the Nina, appears to be that they should be duplicates, and that when joined they should form one screw whose dimensions should be those which good engineering practice would give to a single screw.

The Kunstadter system possesses the advantage that it requires no special adaptation of the engine, and can be applied to a vessel already fitted with the ordinary screw at but little more cost than if made for her in her original construction.

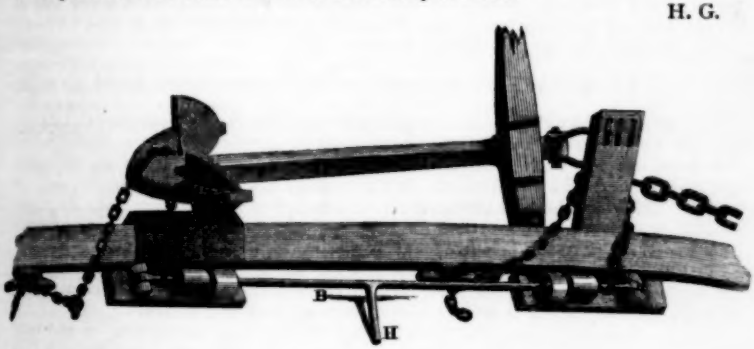
The immense advantages arising, especially for fighting vessels, from superior manœuvring power are so numerous, and the improvement in this respect offered by the Kunstadter system is so great, and involves so little cost or complexity, that the board in its report recommends the application of the system to all screw steamers of the Navy.

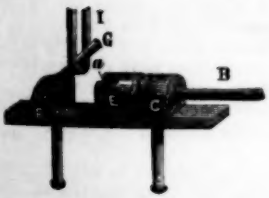
J. K. B.

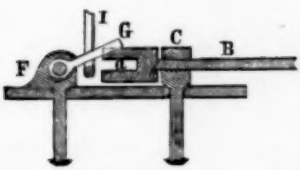
NOTE.

The U. S. Patent No. 275,529, granted to T. H. Sellers, of Vallejo, Cal., is for a very simple and effective boat-detaching apparatus that has been successfully applied to several of our vessels of war in the Pacific. The device is so simple and strong in all its parts that its application was suggested for use in letting go the bower anchors of a vessel of war. The accompanying drawings show the nature of the apparatus and its application to the bower anchors of the U. S. S. Mohican. Certainty of action in clearing the ring stopper and shank painter at the same instant is absolutely secured.

H. G.







Referring to the drawings for a more complete explanation, Fig. 1 is a perspective view of the forecastle of U. S. S. Mohican; Fig. 2 is an enlarged view of one end of the device; Fig. 3 is a section of the same. *B* is a shaft

that extends fore and aft parallel with the ship's rail, and as close to it as possible. The ends of the shaft may be enlarged, as shown at *E*, and have short slots, *a*, cut in one side, extending to or just beyond the central line or axis of the shaft. Beyond the ends of the shaft are boxes *F*, which, for convenience of fastening and solidity, may be formed upon or secured to the same base with the boxes *C*. Bolts *G* have one end pivoted in the boxes *F*, so that their free ends may turn in a line with the axis of the shaft and lie in slots *a*. The shaft *B* has a lever, *H*, at any suitable point, by which it can be rotated, so that when the ends of the bolts are in the slots, by turning the lever up the slot will face downward, and the bolts cannot be withdrawn until the shaft has been again turned with the slot upward. A link, *I*, is made to fit over each of these bolts, being the standing part of the ring stopper and shank painter.

The operation will be as follows: The bolts *G* pass through the ends of the links *I* and enter the slots *a*. The shaft *B* is turned so that the slots are below horizontal position, which prevents the bolts coming out, and the ring stopper and shank painter are hauled taut and belayed to cleats inside the rail as usual. A half-round chock shod with iron is placed inside the rail in wake of the ring stopper and shank painter to take any chafe. In letting go anchor the lever *H* is first released from a catch which steadies it against the rail and turned down as shown in the drawing until the slots at the end of the shaft are open, when the links are released and the anchor is entirely clear.

TORPEDO WAR AND SUBMARINE EXPLOSIONS.

By Robert Fulton, Fellow of the American Philosophical Society, and of the United States Military and Philosophical Society. New York: Printed by William Elliott, 114 Water Street. 1810.

The Liberty of the Seas will be the Happiness of the Earth.

The above is the title of a rare pamphlet, in the Navy Department Library, written by the great Fulton and addressed to President James Madison and the members of both Houses of Congress, giving a description, with five engravings, of some experiments and details of his method of torpedo defense and attack, which he had unsuccessfully attempted to introduce into the naval establishments of England and France, and which he sought to have adopted as a principal part of our national defense.

The subject being now treated by the Fortifications Board, a comparison of the state of the art of torpedo warfare by the statement of its effectiveness and reasons for employing it will prove interesting and instructive.

Fulton first describes the blowing up of the brig Dorothea, of 200 tons burthen, near Deal, in 1805; done to convince Mr. Pitt and Lord Melville that a vessel could be destroyed by the explosion of a torpedo under her bottom. A torpedo containing 180 pounds of powder was attached to either end of a line 80 feet long stretched between two boats, which then rowed down on the brig until the line struck the cable, when the torpedoes were cast overboard, and, being not quite buoyant, the tide carried them under her bottom.

The destruction of the vessel was complete, and much impressed the officers present, who were previously very dubious as to the value of torpedoes.

In a note Fulton says:

"The morning of my first interview with Earl St. Vincent he was very communicative. I explained to him a torpedo and the Dorothea experiment. He reflected for some time, and then said: 'Pitt was the greatest fool that ever existed, to encourage a mode of war which they who commanded the seas did not want, and which, if successful, would deprive them of it.'"

A similar experiment to that on the Dorothea, made in New York Harbor in 1807, is also related.

Fulton's anchored torpedo consisted of a copper case containing 100 pounds of powder made buoyant of cork. The firing apparatus consisted of a brass box containing a gun-lock, with a barrel two inches long containing a musket-charge of powder; a ship striking the trigger fired the torpedo. The whole was secured to an anchor by a line of such a length that the torpedo would come to within from 10 to 15 feet of the surface at low water.

For torpedo attack, Fulton shows a picture of a "clockwork torpedo as prepared for the attack of a vessel while at anchor or under sail, by harpooning her in the larboard or starboard bow." The torpedo is the same as before described, except that it is fired by clockwork and suspended from a cork float at a depth depending upon the draught of water of the vessel to be attacked. His plan of attack was to run up at night to within 30 to 50 feet of the bow of a vessel anchored in a tideway, or under sail, and fire his harpoon from a blunderbuss mounted in the stern of the rowboat, throw the torpedo overboard, after starting the clockwork, and pull away.

This was twice tried by English officers on French brigs in Boulogne Roads, but without effect, owing to some defect in the method of suspending the torpedoes which made it impossible for the tide to sweep them under the bottom.

The defense of a harbor against the attack of an 80-gun ship, with a full crew of 600 men, by an equal number of men in 50 boats, is described, and great stress laid on the economy of torpedo defense, as it is estimated that the 50 boats, with torpedoes and arms complete, would cost but $25,000, whereas the value of an 80-gun ship was $400,000. This is now a common argument in favor of torpedoes; but the ratio of the cost is probably not so favorable at present, as the boats were then estimated to cost $100 each, and now a 28-foot cutter costs about $800, and a torpedo boat from $30,000 to $50,000. Fulton covered almost every point now considered of value in a modern torpedo boat. He provided four marines to each boat, to keep up a running fire, and estimated that if a vessel were attacked at night, a boat, even if detected at a maximum distance of 300 yards, would not be under fire for more than four minutes. With regard to the danger of such an attack, he says "that the men in the boats, who are not more than three minutes within the line of the enemy's fire, are not so much in danger, nor does it require so much courage, as to lie yard-arm and yardarm, as is now usual in naval engagements, and receive broadsides, together with grape shot and volleys of small-arms, for fifty or sixty minutes. It is not so great a risque, nor does it require so much courage, as to approach a vessel in boats, climb her sides, and take her by boarding. Yet this has been frequently done."

His estimate for the required force was as follows:

"*Estimate for an Establishment in Our Most Important and Vulnerable Ports.*

	Boats.	Anchored Torpedoes.	Clockwork Torpedoes.
Boston	150	300	300
New York	150	300	300
In the Delaware	50	200	100
Chesapeake	100	200	200
Charlestown	100	200	200
New Orleans	100	200	200
Total	650	1400	1300

650 boats at three hundred and thirty-six dollars each $218,400
1400 anchoring torpedoes, eighty-four dollars each 117,600
1300 clockwork torpedoes, one hundred and fifty dollars each 195,000
Total $531,000

"Having mentioned the ports in which it is most probable the enemy would attempt to make an impression, calculations can be made for a like mode of defending other stations—a minutiæ which I am not prepared to enter into, nor is it necessary, in the present state of this disquisition. I have shown a strong power, in boats and torpedoes, to defend six of our principal ports. Gentlemen will please look to the numbers allotted to each port, and reflect whether an enemy would not be inclined to respect a force so active and tremendous in consequences; a force which, under the cover of the night, could follow them into every position within our waters, and pursue them for some leagues from our shores into the open sea; yet those establishments would not require an expenditure of four hundred thousand dollars; for the cutlasses and firearms to arm the boats, and the powder for the torpedoes, are already in our arsenals and magazines. And what is four hundred thousand dollars in a national point of view? A sum which would little more than build and fit out two ships of 30 guns. After reflecting on these experiments and demonstrations, I hope no one will for a moment hesitate in deciding that the two thousand seven hundred torpedoes and six hundred and fifty boats before estimated will be a better protection for six of our seaports than two ships of thirty or any other number of guns. To man the boats in the different ports, nothing more will be necessary than a marine militia; they can be as numerous as any possible necessity could require; and should be exercised to row, and use the torpedoes until the practice became familiar; after which, practice once a month would be sufficient. Corps thus formed would be no expense to the National Government; torpedoes would require no repairs, and the boats, carefully laid up in houses built for the purpose, would last many years."

In closing the pamphlet, he takes a view of the political economy of the invention, and, with singular shortsightedness, argues that it will relieve us from the necessity of maintaining a navy. He states at length the power of the English Navy, and the expense of maintaining it; showing, also, that our trade with England furnishes her with funds to support a navy. He admits that navies will continue to exist, but argues that his system of torpedo defense will prevent them from oppressing the United States, neglecting entirely the protection of our mercantile marine. F. T. B.

REVIEWS.

REPORT OF THE SUPERINTENDENT OF THE U. S. COAST AND GEODETIC SURVEY, SHOWING THE PROGRESS OF THE WORK DURING THE FISCAL YEAR ENDING WITH JUNE, 1884.

This report contains, with other matters, a detailed account of the work performed during the year ending with June, 1884, by officers of the Navy attached to the Coast Survey, together with a cordial acknowledgment by the Superintendent of the value of these services. It appears that, in accordance with the law which authorizes the employment of naval officers in the Coast Survey, there were employed in this service, during the year above indicated, one Commander, three Lieutenant-Commanders, twenty-three Lieutenants, forty-four Ensigns, eight P. A. Surgeons, one Assistant Surgeon, one P. A. Paymaster, and six P. A. Engineers, making a total of eighty-seven officers. The work done by the Navy was principally hydrographic work, and on this duty eleven steamers and twelve schooners were engaged. These vessels were all commanded by naval officers and manned by sailors detailed from the Navy.

The aggregate amount of work performed by this force, which was divided into twenty-four parties, was as follows: Number of soundings taken, 481,008; area sounded in square miles, 4631; number of miles run while sounding, 12,846.

The hydrographic work of the Coast Survey was under the general charge of Commander C. M. Chester, assisted by Lieutenants Pillsbury and Moser. The steamer Blake, Lieutenant-Commander W. H. Brownson commanding, was employed in making hydrographic examinations in Vineyard Sound and on Nantucket Shoals, and in hydrographic work in Long Island Sound. The steamer A. D. Bache, Lieutenant H. B. Mansfield commanding, was engaged in resurveying the approaches to New York, and in new surveys on the west coast of Florida. The steamer Hassler, Lieutenant-Commander H. E. Nichols commanding, made a hydrographic reconnaissance of the bays and harbors of Southeastern Alaska, and afterwards, under the command of Lieutenant-Commander A. S. Snow, a hydrographic survey of the Strait of Fuca, W. T.

The other important hydrographic work performed was as follows: Surveys between Cross Island and Nash Island, and in Narragugus Bay and River, coast of Maine; numerous surveys in Long Island Sound, Delaware Bay, Chesapeake Bay, south branch of the Elizabeth River, and on the coasts of Louisiana and Texas. On the Pacific Coast, a survey of the vicinity of Point Buchon, California, and an examination of the bar at the entrance to San Francisco Bay were made; and also surveys at other points on the coasts of California and Washington Territory.

In addition to the work above mentioned, Lieutenant Pillsbury made numerous hydrographic examinations along our Eastern and Southern Coasts as a preparation for the revision of the *Atlantic Coast Pilot*. Lieutenant Fremont made a number of current observations off New York entrance and on the east coast of Florida.

Commander Chester, assisted by Lieutenant Clover, superintended the construction of the U. S. Coast and Geodetic-Survey steamer Carlisle P. Patterson, a vessel intended for service on the Pacific Coast.

The above record of hydrographic work is an account of the service of naval officers in the Coast Survey for a single year. The work is continued from year to year, and as discoveries are made affecting the navigation of our coasts they are immediately reported to the Coast-Survey Office at Washington, and the necessary information regarding them is issued to seamen at once by the Superintendent of the Coast Survey. It is evident that, owing to the constant changes which are taking place in all the harbors and other water-ways along our coasts, this service is indispensable to the safety of our commerce. The Superintendent of the Coast Survey has very justly given credit to naval officers for the faithful performance of this important duty.

B. F. T.

BIBLIOGRAPHIC NOTES.

AMERICAN GEOGRAPHICAL SOCIETY, BULLETIN No. 2, 1885.

John Cabot's Landfall, Site of Norumbega, by Prof. E. N. Horsford, of Cambridge.

An interesting and thorough study of the subject, accompanied by a set of heliotype maps and sketches.

Conclusions: 1st. That the site of the Landfall of John Cabot in 1497 has been determined to be Salem Neck, in latitude 42° 32′ N.; the Norum (the Neck, to one standing on it) of the Norumbega of Cabot, and the Nahum of the Nahumbeak of Ogilby and Smith. The first land seen may have been Cape Ann, or possibly the mountain Agamenticus.

2d. That the town of Norumbegue, the fort of that name, and the village of Agoncy, were on the Charles River, between Riverside and Waltham, in latitude 42° 21′ N. (Middlesex Co., Mass.).

3d. That John Cabot preceded Columbus in the discovery of America.

Life and Scenery in the Far North, by Wm. Bradford.

A graphic description of a summer trip to the west coast of Greenland in the steam sealer Panther (450 tons), described as having a sheathing of Australian ironwood 4 inches thick over her usual planking of 5 inches thickness; her stern was sheathed with heavy boiler iron; forward she was sheathed and built up solid for 12 feet abaft the stem; inside she was supported by heavy oak beams placed at every ten feet to resist transverse pressure. The paper gives an interesting account of the ice-navigation, scenery and native customs of the west coast. J. W. D.

AMERICAN SOCIETY OF CIVIL ENGINEERS, TRANSACTIONS.

OCTOBER, 1885. New method of making conventional signs on original topographical maps, by J. A. Ockerson.

The great saving in time and expense, also the even quality of the work produced, should recommend this new method to draughtsmen, the Naval Service and the Coast Survey.

If the appropriate rollers and outfit were supplied to surveying vessels, the draughtsman could put in the outlines of the maps, water-courses, roads, etc., while any officer attached to the vessel could, after a little practice, print in the conventional signs, lettering and soundings. W. P. C.

ANNALEN DER HYDROGRAPHIE.

PART X. Cruise of the Niobe on the coasts of Norway, England and Scotland. Tidal and weather information. Cruise of the Asia on the Pacific Coast of Central America. Description of a pampero in the South Atlantic. International lighthouses.

PART XI. Best determination of observation-point from altitudes of a star. The German gunboat Iltis in the Min River. Deep-sea

soundings in the Gulf Stream and on the east coast of North America; a résumé of the work of the Albatross.

PART XII. Cruise of the German corvette Bismarck on the west coast of Africa. The climate of Port Stanley and the Falkland Islands.

CRUISE OF THE AUSTRIAN CORVETTE AURORA TO BRAZIL AND THE LA PLATA IN 1884–1885.

CRUISE OF THE AUSTRIAN CORVETTE FRUNDSBERG IN THE RED SEA AND ON THE EAST COAST OF AFRICA IN 1884–1885, published by the Mittheilungen a. d. Gebiete d. Seewesens.

A small part of these volumes is devoted to a brief sketch of the vessel's cruise and of the ports visited; then follows an immense amount of statistical and commercial information in regard to the countries visited. This information is of the most minute character, and cannot fail to be of great value.

J. T. S.

ENGINEER.

JANUARY 1, 1886.

In the annual review of engineering progress, under the head of "Mechanical Engineering," it is stated that no decided advance has taken place in marine work during the past year, and nothing is now heard of the great pressures, such as 160 pounds, 180 pounds, and even 200 pounds, talked about this time a year ago. It seems generally accepted as proved that nothing is gained by going beyond 150 pounds. Some quadruple-expansion engines have been tried. The results have not been encouraging. They are in no sense better than those obtained from triple-expansion. The triple-expansion engine has proved itself to be just so much more economical than the ordinary compound that its use covers the whole cost of insurance, and in certain cases gives a margin besides. Two-cylinder compound engines are being rapidly and completely superseded by the triple engine, as they superseded the low-pressure engine and jet condenser. If business in the shipping world would get a little better, plenty of work would be found for engineers in converting the existing double-cylinder engines into triple engines.

In the mercantile marine no advance has been made in the adoption of forced draught. In the Navy, on the contrary, forced draught is becoming the rule instead of the exception. The method adopted is to enclose the fire room, in order to put it under pressure, by getting a horizontal ceiling about ten feet above the floor plates, extending from the coal-bunker bulkheads to the front of the boilers, and from this ceiling vertical screen plates are carried down between and at the ends to meet the front boiler-bearers. By this means the fire room proper can be readily converted into closed, air-tight chambers of comparatively small dimensions. The first ships of the Navy to which this system was applied were the Satellite and Conqueror. During a four hours' trial the Satellite, with natural draught, developed 10.15 I. H. P. per square foot of grate; with an air pressure of 1¼ to 2 inches of water in the fire room the power rose to 16.9 I. H. P. In the Conqueror natural draught gave 8 I. H. P. per square foot of grate, and forced draught 16.46. In the trial of the ironclad Rodney last year an air pressure of 2 in. gave 17.3 I. H. P. per square foot of grate. It may be taken as proved, therefore, that an air pressure of 2 inches of water in fire room will augment the boiler efficiency by 70 per cent. This augmentation also permits a great saving to be made in the weight of boilers and machinery. With forced draught an indicated horse-power can be obtained from two cwts. of machinery.

JANUARY 8. Liquid Fuel.

For some time past experiments have been made at Portsmouth Dockyard on petroleum as fuel. A method of burning creosote, patented by Col. Sadler, is being tested there. It seems that the boiler used will evaporate ten pounds of water per pound of coal burned. With creosote as fuel the ratio becomes one to thirteen, the pressure being 60 pounds. Many attempts have been made to use mineral oils as fuel, but none of them have resulted in commercial success. Mr. Ayrdon was the first engineer who succeeded in this country in burning liquid fuel in a steam boiler. He effected his object by injecting the fuel in the form of spray by the aid of a jet of steam; and nothing to rival this system has ever been discovered.

An average sample of petroleum contains—carbon, 85 per cent.; hydrogen, 13 per cent.; and oxygen, 2 per cent. Its calorific value is very high, because of the large quantity of hydrogen. Petroleum will evaporate theoretically about 18 pounds of water per pound of oil. Its calorific value may be taken as two and a half times that of coal, while the value of the crude oil is a little less than twice that of coal. In practice, however, no such results have ever been obtained; and, because attention is being once more directed to the subject and hopes may be formed which cannot be realized, it is well that something should be said of the practical difficulties which stand in the way. Since petroleum is about twice as dear as coal, it must be twice as efficient, to be burned with equal economy; but a practical evaporation of 20 pounds of water per pound of petroleum has never been obtained. Petroleum is a very difficult thing to burn to advantage, because of the enormous amount of smoke which it produces. The smoke itself does not necessarily represent much loss of fuel, but the deposited soot does, because it coats the heating surfaces with an admirable non-conductor. To prevent smoke, the fuel must be burned with a large supply of air in a brick-lined chamber, which will prevent the rapid cooling of the gas and partial extinction of the flame. This entails a very important modification in the structure of a boiler, and any attempt to use petroleum in existing marine boilers practically deprives them of the heating surface of the furnaces, because these must be lined with fire-brick if the combustion is to be complete. It appears certain that the total efficiency of a marine boiler burning liquid fuel must be lowered. This is a simple deduction from theoretical considerations, but it has hitherto been borne out in practice, for the Himalaya, the steamer which recently made a run to Leith with liquid fuel, could not keep steam to anything near the proper pressure, and the experiments made at Portsmouth have so far ended the same way.

A serious objection to the use of liquid fuel is that a very considerable quantity of steam is required to blow the fuel in the furnace. This steam acts on the fuel precisely as it would on water in an injector. It is condensed and enters the furnace as so much water, which has all to be re-evaporated. The quantity used has never been ascertained with any exactness, but it is of importance. With long voyages and high pressures, steam would have to be furnished by a supplementary boiler working with salt water at a low pressure, or else special distilling apparatus must be provided to furnish fresh water to the main boilers. This is a second and very serious obstacle to the use of liquid fuel at sea.

The great merit claimed for liquid fuel is that a smaller quantity of it than of coal may be carried, or that a given weight would take a ship much farther than would a similar quantity of coal. Bulk for bulk, liquid fuel will occupy as much space as coal. If, however, it can be shown that a ton of liquid fuel will do as much as a ton and a half of coal, then space may be saved or the duration of cruises prolonged. It may also be urged, and with justice, that the number of hands in the fire room may be reduced. In the mercantile marine petroleum has no chance whatever: the price must always prove fatal to its success. In the Navy, price is a secondary consideration; but it must not

be forgotten that even a small shell exploded in a mineral-oil tank would produce the most appalling results.

The principal point to be decided is, however, the possibility of burning the oil to advantage at sea. This has yet to be proved. Until this is done, it is useless to point out objections to the use of a comparatively volatile, inflammable fluid as fuel.

JANUARY 29. The U. S. S. Chicago.

In an editorial on the subject of the Chicago's boilers and engines, the following opinions are expressed: "The design of the machinery has undergone important modifications, but the principal objectionable features have been perpetuated, and we are in some doubt as to which design is the worst. There was ample space in the ship for horizontal engines, but her designers have used beam engines; why, it is very difficult to explain. The ship is unarmored, and it was therefore desirable to keep her machinery as far below the water line as possible. As the crank shaft stands about four feet above the level of the floor plates, no difficulty would have been experienced in putting horizontal engines in with low-pressure cylinders 78 inches in diameter, and the entire height of engines need not have exceeded 10 feet. The engine room of the Chicago, with its four working beams, will present a sight which will strike English eyes as archaic. Concerning the proportions of parts adopted little need be said. Things seem to have been made big enough and heavy enough. Yet we doubt that 14½ inches is a sufficient diameter for the crank pins, and if the main centres of the beams do not give trouble when the ship is in a seaway, we shall be much surprised.

"The engines are enormously heavy, not less than 3.32 cwts. per indicated horse-power, which is much in excess of the results obtained in the British Navy.

"The boilers are of worse design than the engines, and will no doubt be pulled out after a cruise or two. Criticism sufficed to produce a departure from the original design, but it has not made matters any better. The grates are of the most unwieldy dimensions, being no less than 8 feet wide by 7 feet long. So much doubt has been expressed concerning the power of the boilers to furnish dry steam, that a superheater has been added, which cannot be used when the ship is going into action—that is to say, just when dry steam will be most wanted. The superheater seems to have been specially constructed to do the greatest possible harm when it explodes, as it is sure to do some day. In looking over the drawings of this machinery, we see the results of all the experience laboriously and expensively acquired in this country cast to the winds, and a design which is only not experimental because it is a relic of the past, vamped up and made to do duty as something new." J. K. B.

FRANKLIN INSTITUTE JOURNAL.

DECEMBER, 1885. Scientific Method in Mechanical Engineering.

An introductory lecture to the Course on Mechanics at the Franklin Institute, by Mr. Coleman Sellers.

The Tatham Dynamometer, by W. P. Tatham.

JANUARY, 1886. Electricity in Warfare.

A lecture delivered before the Franklin Institute, illustrating the various applications of electricity in warfare, by Lieutenant B. A. Fiske, U. S. N.

Steam-Vessel Indicator. Novelty Electric Works. Philad.

J. K. B.

GIORNALE D'ARTIGLIERIA E GENIO.

Nos. IX. and X. of 1885. Official descriptions and working drawings of various implements of the Artillery and Engineers.

R. C. S.

JOURNAL DU MATELOT.

No. 46, 1885.

Notwithstanding the many advantages presented by hydraulic-propulsion torpedo boats, it does not seem at all probable that they will replace those driven by screws, as they disturb the water to such an extent that they can easily be detected with a glass at a distance of a thousand yards on a clear night, and, if the sea be phosphorescent, at double the distance, if not farther.

C. B.

MECHANICAL ENGINEER.

NOVEMBER 28, 1885. The U. S. S. Chicago.

A full description with detailed dimensions of the hull, boilers, engines and auxiliary machinery of the cruiser Chicago, illustrated by four large cuts; and a valuable article on twin-screw naval cruisers, containing the general dimensions of the principal foreign unarmored cruisers now under construction, and the performance of those recently finished.

DECEMBER 12. Forced Combustion.

An article descriptive of the various methods that have been tried for inducing an increased draught by artificial means, together with a comparative table showing the coal burnt per square foot of grate, and indicated horse-power per square foot of grate developed by modern vessels of war under natural and the different methods of forced combustion.

Compression.

A mathematical investigation into the subject of compression in steam cylinders, with the object of showing when compression is useful and when disadvantageous. By Sven Brunau, M. E., Sweden.

JANUARY 9, 1886. Wheeler's Improved Surface Condenser.

In this condenser the tubes are entirely independent in regard to endwise expansion: they can expand freely without detriment to themselves or any other parts. They are free from tube ferrules or packing of any kind; having a screwed connection with the tube sheets, the exhaust steam enters above the tubes in the upper part of condenser, passes over a scattering plate, preventing the steam impinging upon the tubes. The upper part of condenser above the scattering plate is large; the pressure and temperature of the steam are consequently reduced to some extent by expansion before striking the cold tubes. The tube arrangement is as follows: A small tube is expanded into a screw head, which latter screws into the front tube sheet. A short distance from this sheet is a second tube sheet, into which a larger tube is screwed, the tube end being drawn thick to permit of its being threaded. The small tube passes into the larger and ends within a few inches of a screwed cap closing the outer end of the large tube, giving ample space for the water to reverse its direction before flowing back through the annular space between the two tubes. The injection water is pumped into the compartment between the front tube sheet and condenser bonnet, passing through small inner tubes, returns around them through the outer ones, and discharges into the compartment between the first and second tube sheets and leaves the condenser through the outboard discharge valve. Whenever it is necessary to remove the tubes for cleaning, etc., both small and large tubes can be drawn out from the same end of the con-

denser, as the screw-head into which the small tube is expanded is larger than the thickest part of the large tube.

The Lighthall Manufacturing Company claim that by carefully conducted tests these condensers have shown 200 pounds condensed steam per hour per square foot of condensing surface.

[It would be well to state, in connection with this latter statement, that in the experiments made by Joule it was found that by carrying the injection from 68° to 77° only 100 pounds per square foot of cooling surface could be condensed under very favorable conditions, while in practice with compound engines, using composition condenser tubes, 15 pounds steam per square foot of condensing surface is considered excellent work.

Under these circumstances, it would appear that the claim made for the Wheeler condenser is rather in excess.—EDITORS.]

Screw Propellers of the Boston and Atlanta.

A description of the screws fitted to the above vessels, with a method of laying down a Hirsch screw propeller for any given vessel.

MARCH 6. Comparative Performance of Merchant Steamers.

Tables containing the principal dimensions and average performances of a number of leading vessels in the English merchant marine, together with a method of laying down the curves of speed and power of steamships.

J. K. B.

MITTHEILUNGEN A. D. GEBIETE D. SEEWESENS.

VOL. XIII. No. IX. Historical sketch of the development of nautical instruments for measuring angles. English evolutionary squadron in 1885. Translation of Lieutenant Ingersoll's paper, Corrections for wind, etc., which appeared in No. 33, Proceedings of the Naval Institute. English Navy. Trial of the Rodney's Machinery. Torpedoes. French Navy. Sinking of two torpedo boats and of the dispatch vessel Renard. Russian Navy. Use of naphtha as fuel for torpedo boats. Italian Navy. The armorclad Lepanto. New torpedo boats for Germany and China.

Nos. X. and XI. The works on naval warfare of the future. The manœuvres of the Italian Practice Squadron in 1885 (with chart). The Moncrieff-Laffete system for Russian ironclads. The English Navy. Torpedo boat Grasshopper. The Brotherhood system of steam-steering machinery. Electric lighting on board ship. Trial of the Impérieuse. The Berdan torpedo. The Nordenfeldt submarine torpedo boat.

J. T. S.

NORSK TIDSSKRIFFT FOR SOVAESEN. HORTEN, NORWAY.

Numbers 1, 2 and 3 of the 4th year of the Norwegian *Maritime Journal* have been received.

No. 1 contains an account of the capture of the Pescadores Islands by the French in the Franco-Chinese War, written by Premier Lieutenant Rosenquist. The article contains a map and full details of the operations.

The second article is a paper by Captain Gasmann, "Armored or Unarmored." This essay is a study and a compilation from *Journal of the Royal United Service Institution;* the article "Étude sur les combats livrés sur mer de 1860 à 1880," in the *Revue Maritime et Coloniale* for 1881; the article "La réforme de la Marine," from *Revue des deux Mondes*, 1884, and "Das Torpedo Gagdshiff," from the *Mittheilungen aus dem Gebiete des Seewesens*, translated from *Rivista Marittima.* The paper is concluded in No. 2, and

introduces all the elements which render the question of the value of armor so complicated.

There is a short résumé of an article on "International Lights and Lighthouses," from *Shipping Gazette and Lloyd's List Weekly Summary*. This is followed by a complete descriptive list of all the vessels of the Swedish Navy. All the particulars of each and every ship are given in tabulated form. The "Miscellaneous" chapter contains short articles on "The Torpedo Chaser," "New American Cruisers" (additional vessels), the new electric boat Volta, and an account of Nordenfeldt's submarine boat taken from the *Broad Arrow*. The remainder is taken up with official intelligence, movements of officers, general orders, etc.

The second number of the fourth year contains the conclusion of Captain Gasmann's essay, "Armored or Unarmored." "Day Signals," from the *Weekly Summary Lloyd's List*. A complete descriptive list of all the vessels of the Norwegian Navy, with all the particulars of each and every vessel in tabulated form. An article on Lighthouse Illuminants, with the conclusions of the Trinity House Committee on the relative merits of electricity, gas and oil.

The "Miscellaneous" chapter contains articles on the Dynamite Gun, from *Scientific American* of October 24th, 1884. An account of a novel steamboat, from the same paper. This is a steam catamaran; the two cigar-shaped floats have screws which are revolved by a steam engine placed on a superstructure over the floats. A short article "Defense against Torpedoes," from the *Broad Arrow*, is especially interesting in connection with Captain Gasmann's essay. The chapter closes with a brief account of the progress of torpedo-boat building in Germany by the firm of F. Schichan & Co. at Elbing. The usual official intelligence concerning movements of officers, general orders, etc., concludes the number.

The 3d number of the 4th year has the following contents: "Coast Defense at Home and Abroad," by Reserve Lieutenant Müller. This article quotes that entitled "The Defense of Our Coasts," from *Engineering* of May 1, 1885, and discusses the condition of the Norwegian coast defenses, and measures necessary to defend them and their approaches.

The second article is a translation of Captain Galwey's paper, "The Use of Torpedoes in War," from the *Royal United Service Institution*. Then follow: "Liquid Fuel," from *Nautical Magazine*. "The Lighting of the Suez Canal," from *Weekly Summary*, giving the recent regulations allowing men-of-war and mail steamers having electric lights to navigate certain portions of the canal at night.

The "Miscellaneous" chapter contains: An article on "Experiments with Machine Guns," from *Army and Navy Gazette*. The definition of a ton. "A Torpedo Chaser," from *Engineering* of Nov. 27, 1885. Description of Goubet's submarine boat, from *Engineering* of Nov. 20, 1885. A brief notice of the "Effect of Electricity upon Ships' Compasses," with certain precautions to be taken. The number concludes with the usual official intelligence.

W. H. B.

REVUE MARITIME ET COLONIALE.

DECEMBER, 1885.

This number of the *Revue* contains an article by M. Besson, Enseigne de vaisseau in the French Navy, describing an apparatus for illuminating the vernier and limb of a sextant in order to facilitate reading the instrument at night. The apparatus consists of a very small incandescent electric light which is attached to the index bar. The electricity is supplied by a small battery in which bichromate of potash is used, and the battery is arranged to act only at the will of the observer.

The practical difficulty in employing such an apparatus is with the battery.

Unless the plates are carefully cleaned every time it is used, they become polarized very rapidly, and are soon unfit for use. On account of the labor involved in taking care of the battery, it is doubtful if the apparatus will prove of any practical value. The excellent bull's-eye lantern which is supplied in our service answers every purpose for night observations, where the difficulty is not in reading the instrument, but in discerning the horizon clearly.

French swift cruiser Taze, building on the Loire.

To be of steel, twin screws, and protected by an armored deck. Length between perpendiculars 389 ft. 6 in., extreme breadth 53 ft. 9 in., depth 35 ft. 11 in., mean draught 19 ft. 9 in., difference of draught 3 ft. 7 in., displacement 7045 tons. Besides the usual division into compartments, a cellulose belt will aid the floatability. The screws will be driven by independent, three-cylinder, horizontal engines; to develop, with natural draught, 8115 H. P.; with forced draught, 10,330 H. P. She is to have nine auxiliary engines to work pumps, ventilating apparatus, etc. The boilers to be in three independent groups, four cylindrical boilers in each group. To carry fourteen hand pumps for various purposes, and in addition two steam pumps capable of discharging 1000 tons of water an hour and a third pump capable of discharging 90 tons an hour, intended principally to discharge the water ballast. She will be lighted entirely by electricity. To be armed with six 6.26-in. on the forward and after parts, ten 5.57-in. in battery, three 1.84-in. rapid-firing guns and twelve Hotchkiss 1.45-in. cannon revolvers; and to carry seven Whitehead torpedo tubes above the water line.

The speed of the Taze is expected to be 19 knots. She is to have three masts. Total cost, 8,750,000 francs; 3,500,000 for engines and boilers.

Russian ironclad Admiral Nakhimoff.

Launched October 22, on the Neva. The most powerful man-of-war built in Russia with native iron and steel. Dimensions: length 360 ft. 10 in., breadth 61 ft., draught 22 ft. 35 in., displacement 7781 tons. Engines to develop 8000 H. P.; speed 16 knots. Armament: eight long, VIII-in. cannon in the turrets; ten VI-in., and tubes for discharging torpedoes. Armor 7.93 in. at the water line, and 9.8 in. at the turrets. B. F. T.

ROYAL UNITED SERVICE INSTITUTION JOURNAL.

No. CXXX. Liquid Fuel for Marine Purposes, by Vice-Admiral Selwyn, R. N.

The advantages of liquid fuel are briefly stated: "To burn liquid fuel instead of coal requires no change in engines or boilers, and only such an adaptation of the furnaces as can be readily carried out in each ship by her own artificers and engineers; at the same time, it removes the necessity of a whole army of stokers and coal trimmers. It enables a ship to receive her fuel with the greatest facility at sea or in harbor, while proceeding under steam or even sail, is without the nuisance of dust or ashes, and it is not liable either to spontaneous combustion or to deterioration by time, heat or moisture. If the ship gets on shore, it can be run out to lighten her, or be pumped out into lighters with a speed and facility unapproachable with coal; and, lastly, if, as I believe, 46 pounds of water can be evaporated with one pound of fuel, full steaming for *twenty-four* days can be carried on where now we are limited to *four*." This high calorific power is obtained by blowing a jet of steam into the burning oil, when separation taking place, combines some of the hydrogen of the steam with the ignited hydrocarbons. Admiral Selwyn further believes that "in any future war England must either again destroy her enemies' goods —wherever found at sea, under whatever flag—or submit to lose her own commerce, and with it the power of feeding her population. There is no alterna-

tive, and therefore no choice. To carry this out, no condition is more important than increased fuel and better economies of fuel." C. B.

RIVISTA DI ARTIGLIERIA E GENIO.

OCTOBER, 1885. Solutions of problems relating to the trajectory. Rotation of projectiles. Range tables for coast batteries (elevation of battery considered).

An electric small-arm target.

Shows position of hits on a signal disk near the marksman.

NOVEMBER. The small-arm trajectory. The Spezia experiments of October, 1884 (from report of commission).

R. C. S.

RIVISTA MARITTIMA.

OCTOBER–NOVEMBER, 1885. The Italian Navy Estimates (continuation).

R. C. S.

UNITED SERVICE GAZETTE.

OCTOBER 3, 1885. The Severn.

An unarmored fast steel cruiser belonging to the Mersey class; was launched September 29th at Chatham; is 300 feet long between perpendiculars, 46 feet beam, 17 feet 9 inches draught of water, displacement 3600 tons. The engines are horizontal; the I. H. P., 6000; twin screws, estimated speed 17½ knots. The coal capacity is 500 tons; crew, 300; armament, two 8-inch and ten 6-inch B. L. R., one 9-pounder and one 7-pounder boat guns; six 1-inch Nordenfeldts, two Gardners, together with Whitehead torpedoes. The principle followed in the construction has been that of a water-tight hull, and to guard the boilers, engines and magazines as far as possible from danger. She has been two years building, and her cost is about $775,000.

OCTOBER 10. The Hecla.

This torpedo store-ship, having been fitted with a new and smaller screw, was tested, with a result showing an increase of speed from 10.25 to 13.24 knots. This appears to be due to the new screw being proportioned to the steam-producing capacity of the boilers; the I. H. P. showed an increase of 47 per cent. and the speed 13 percent.

OCTOBER 17. Rule of the Road.

Adm. Heath disapproves of Capt. Colomb's advice that when a green light of an approaching steamer is seen slightly on the starboard bow, the course of the ship should not be changed until it is beyond doubt that the two vessels will pass each other to starboard. And another officer writes that Adm. Heath takes a very erroneous view of the question, and that the admiral's advice to starboard the helm three points in the above case is most dangerous, for the officer in charge of the other vessel may see the three lights of the first vessel and put his helm to port at the same moment. The plan recommended by this officer, when a green light is sighted ahead or a little on the starboard bow, is to watch it closely and to signal to stand by in the engine room; so that if the stranger suddenly ports, the ship may be stopped and sent full speed astern and the action signalled at the same time by the whistle. When so much difference of opinion exists in a case of such common occurrence, some definite line of action should be authoritatively enunciated.

The Admiralty have acquired Horsea Island, at the head of Portsmouth Harbor, and are about to spend something over a million dollars on it as a torpedo supply and experimental station. A canal 1000 yards long is to be made as a torpedo range.

Liquid Fuel.

Admiral Selwyn shows that a given steamer burning 300 tons of coal a day for a given speed would require only one-sixth of that quantity of oil to do the same work. Allowing for the difference in cost of coal and oil, there would be a large saving in the cost of fuel in a ten-days' trip, to say nothing of the cost of firemen's wages, provision, firing tools, etc. Additional cargo space would be gained, which would still more increase the balance in favor of oil.

OCTOBER 31.

The armor-plated ship Hero was launched on the 27th inst. at Chatham. She is 270 feet long, 58 feet beam, 6200 tons displacement, 6000 H. P., and will carry two 12-inch 43-ton B. L. R. in turret, four 6-inch 4½-ton B. L. R. on the sponsons, seven 6-pounders, one 9-pounder and two 7-pounder boat guns, one 9-pounder field gun, seven 1-inch, 4-barrel Nordenfeldts, two 0.45-inch, 5-barrel Gardners, and Whitehead torpedoes.

On the same day was launched at Sheerness the Swallow, the first of a new class of fast, heavily-armed gun vessels which will carry eight 5-inch steel B. L. R., eight machine guns and spar torpedoes. She is 208 feet long, 27 feet beam, 1040 tons displacement, and 1500 H. P.

NOVEMBER 28.

In order to encourage English naval officers serving on the East India station in acquiring a knowledge of Persian, Hindustani and Arabic, the Indian Government offers gratuities for passing examinations in these languages. After being qualified, the officer receives a monthly pay of 50 or 100 rupees as interpreter for the ship upon which he is serving, and if the ship be ordered home, he may be transferred to another on the station when practicable.

DECEMBER 5. The Thames.

This schooner-rigged steam cruiser was launched 3d inst. She is built entirely of steel, is 300 ft. long, 46 ft. beam, 3500 tons displacement, and draws 16 ft. forward and 20 ft. aft. She has twin screws, and compound engines with surface condensers; with natural draught the I. H. P. will be 3800; with forced, 5700; the estimated speed is 17 knots. She will carry two 8-in. and six 6-in. guns on Vavasseur central-pivot carriages; six 6-in. broadside; three 6-pdr. rapid-firing guns; six 1-in. 4-barrel Nordenfeldts; two 0.45-in. 5-barrel Gardners, and eighteen Whitehead torpedoes; two electric search lights; 750 tons coal and 300 officers and men. The total cost will be about $750,000.

DECEMBER 19. Liquid Fuel.

The system of Col. Sadler is now undergoing trial at Portsmouth. The fuel consists of creosote which costs two cents a gallon; it is kept in a tank at a uniform temperature and consistency by steam coils inside the tank, and forced into the furnaces by steam injectors. So far the system has proved superior to others previously tried. C. B.

NOTICE.

The Prize Essay for 1886, as awarded in the following letter, and the discussion thereon, will be published in WHOLE No. 38, PROCEEDINGS OF THE U. S. NAVAL INSTITUTE. A few copies of the essay have been printed and sent to the various Branches for distribution, the object being to invite a general discussion of the subject. The Board of Control, therefore, request that the said essay may be read and discussed at each Branch not later than May 12, 1886. The Corresponding Secretaries will please collect all MSS of the discussion at their respective Branches, and forward them for publication to the EDITING COMMITTEE before May 25, 1886.

CHAS. R. MILES,
J. K. BARTON,
Editing Committee.

NAVY DEPARTMENT, *Washington, D. C.*,
February 18, 1886.

LIEUT. J. W. DANENHOWER, U. S. Navy,
Secretary U. S. Naval Institute.

Sir:—The undersigned have had under consideration the seven essays submitted to them by the Board of Control of the Naval Institute for judgment upon their relative merits.

We award the prize to the paper bearing the motto "Scire quod nescias,"* and we consider as worthy of honorable mention the two papers bearing respectively the mottoes "Consilio et animis"† and "The result of all naval administration and effort finds its expression in good organization and thorough drill on board of suitable ships,"‡ in the order named.

We desire to be understood as not necessarily endorsing all the views that are presented either in the prize or the other essays.

Very respectfully,

E. SIMPSON,
Rear-Admiral, U. S. Navy.
MONTGOMERY SICARD,
Captain, U. S. N.
A. P. COOKE,
Captain, U. S. N.

*Lieut. Carlos G. Calkins, U. S. N. †Commander Caspar F. Goodrich, U. S. N
‡Ensign W. L. Rodgers, U. S. N.

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SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1887.

A prize of one hundred dollars and a gold medal is offered by the Naval Institute for the best Essay presented, subject to the following rules:

1. Competition for the Prize is open to all members, Regular, Life, Honorary, and Associate, and to all persons entitled to become members, provided such membership be completed before the submission of the Essay. Members whose dues are two years in arrears are not eligible to compete for the Prize until their dues are paid.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1887. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Judges.

3. The Judges to be three gentlemen of eminent professional attainments (to be selected by the Board of Control), who will be requested to designate the essay, if any, worthy of the Prize, and, also, those deserving honorable mention, in the order of their merit.

4. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Judges.

5. Any essay not having received honorable mention, to be published only with the consent of the author.

6. The subject for the Prize Essay is, *The Naval Brigade: Its Organization, Equipment, and Tactics.*

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of Board of Control.

JNO. W. DANENHOWER,
Lieutenant, Secretary and Treasurer

ANNAPOLIS, MD., *January* 1, 1886.